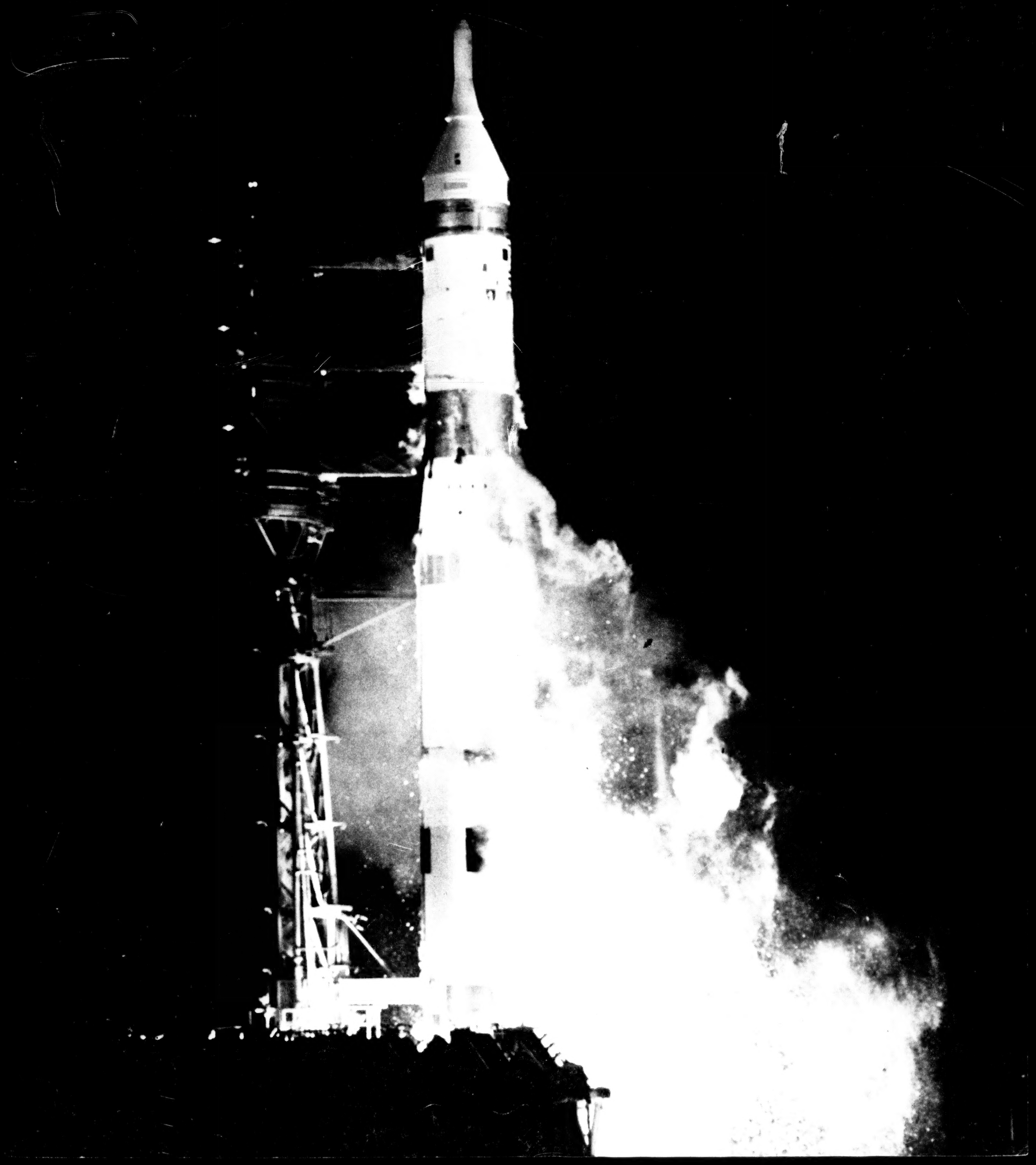
Aviation Week and Space Technology

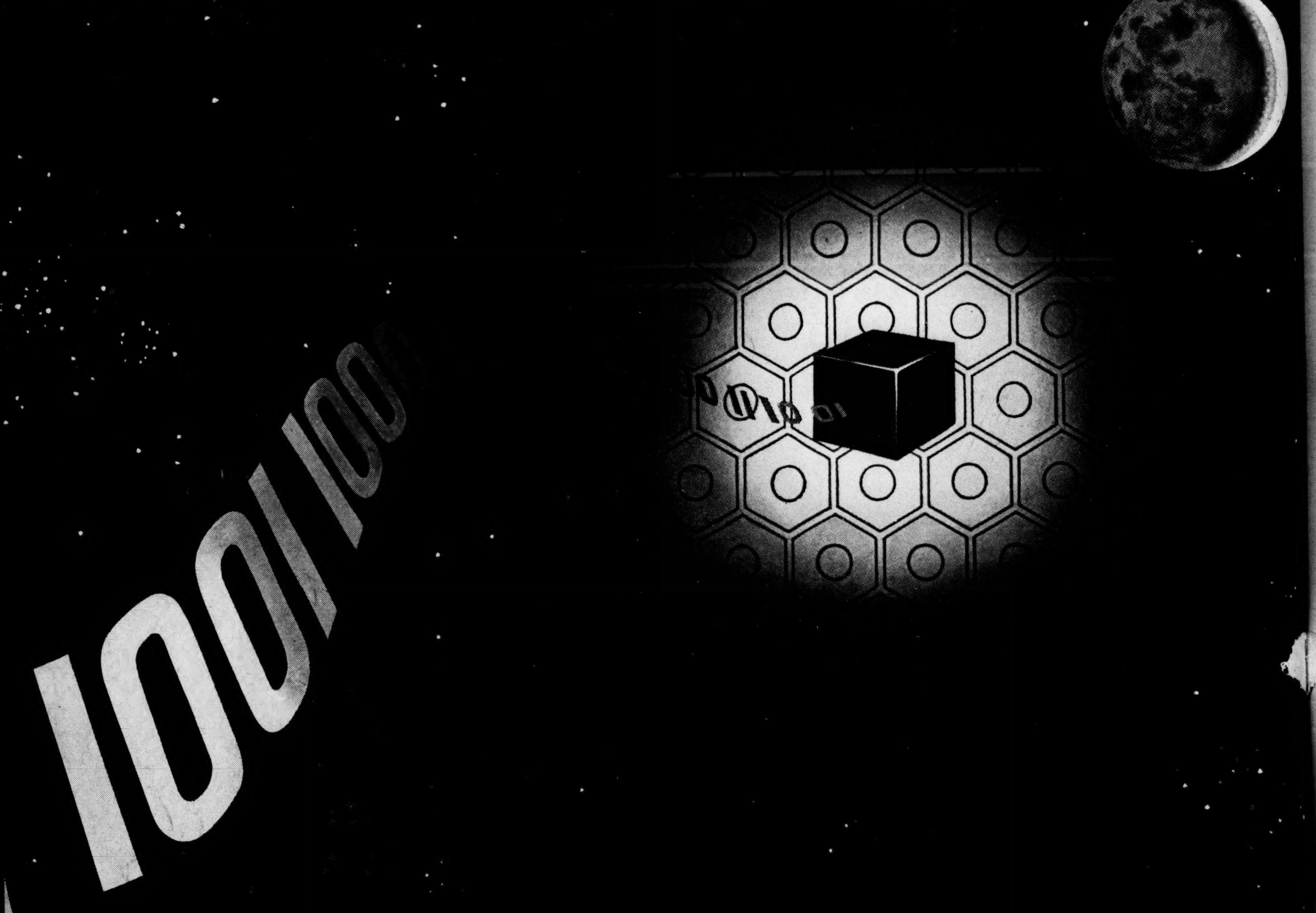
March 6, 1961

Vertol 107 Model II Design Details

Martin Titan With GE Mk. 3 Nose Cone



ANOTHER ASPECT OF THE MARQUARDT MISSION



PNEUMATIC DIGITAL COMPUTERS FOR CONTROLS IN SPACE

An Independent Research Project by The Marquardt Corporation

Advanced control systems, capable of operating in hostile environments with precision and reliability, are the subject of research programs being conducted by ASTRO, Marquardt's division for research into the space age.

One portion of this program is concerned with investigating the application of pneumatic concepts to digital computation for the numerical control of space vehicles and advanced propulsion systems. Based upon simple diode logic, the pneumatic computer combines digital accuracy with the ability to operate under nuclear radiation, vibration and temperature extremes which are destructive to electronic and hydraulic devices.

ASTRO's research investigations involve miniature diode valves which operate without moving parts. When assembled in computer configurations they can carry out all the numerical computations currently performed by their electronic counterparts. The pneumatic digital computer shows promise of providing small volume, light weight, and low cost systems capable of precision control of sophisticated space vehicles and advanced propulsion systems.

ASTRO's research programs into the control problems of space flight are indicative of the knowledge and creative effort being devoted to yet another aspect of the Marquardt Mission.

Creative engineers and scientists are needed.

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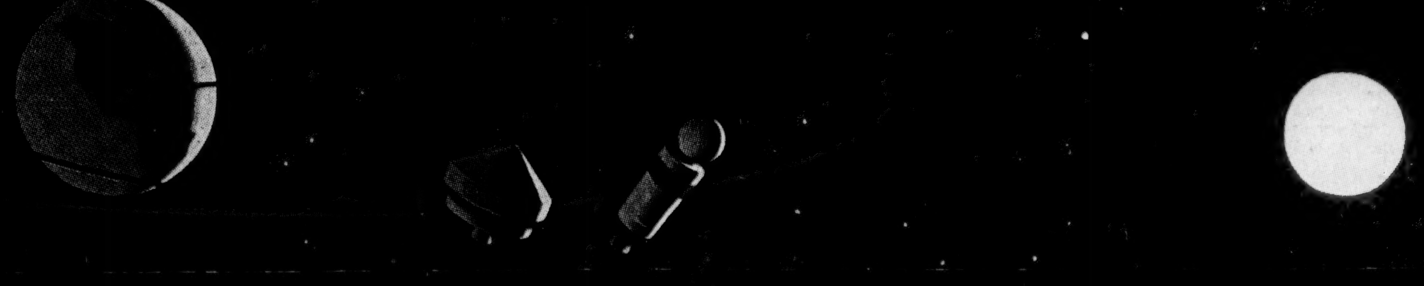

AVIATION CALENDAR

Mar. 12-16—Aviation Conference, American Society of Mechanical Engineers, Statler-Hilton, Los Angeles, Calif.

Mar. 13-16—Missile and Space Vehicle Testing Conference, American Rocket Society, Biltmore Hotel, Los Angeles, Calif.

Mar. 16-18—Fifth National Conference on Aviation/Space Education, Mayflower Hotel, Washington, D. C.

Mar. 17—Symposium on Interaction of Space Objects With Plasmas Outside the Atmosphere, Sheraton-Park Hotel, Washington, D. C.

Mar. 20-23—International Convention, Institute of Radio Engineers, Coliseum and Waldorf Astoria Hotel, New York, N. Y.

Mar. 20-24—1961 Western Metal Exposition, American Society for Metals, Pan-Pacific Auditorium, Los Angeles, Calif.

Mar. 20-24—Western States Regional Convention, Society for Nondestructive Testing, Ambassador Hotel, Los Angeles.

Mar. 23-24—Third Annual Electron Beam Symposium, Alloyd Electronics Corp., Cambridge, Mass.

Mar. 27-31—1961 Symposium on Temperature, Its Measurement and Control in Science and Industry, Columbus, Ohio.

Mar. 28-29—Nucleonics in Flight Symposium, American Nuclear Society, Statler-Hilton Hotel, Dallas, Tex.

Apr. 4-5—Aviation Technician School Administrators Conference, Purdue University, Lafayette, Ind.

Apr. 4-6—International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Apr. 4-6—Lifting Re-entry Vehicles: Struc-

(*Continued on page 6*)

AVIATION WEEK and Space Technology

March 6, 1961
Vol. 74, No. 10

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher. Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

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Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

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Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.

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LET'S
TALK
ABOUT
PEDESTALS

The Greeks had a word for it, which escapes us at the moment. And we should have a better word for it, but we haven't. In this day and age, a pedestal is not a simple device to hold something up. Rather, at least in the electronics industry, it is a unique and complex portion of an antenna system.

Canoga designs, develops and manufactures rugged, reliable, light-weight, low-cost pedestals for almost any radar and telemetry, optical and infra-red use—land-based, ship-borne, on trailers, on roof-tops; for use in the arctic, in the desert or in the tropics.

Canoga pedestals are slim, minimizing wind loading and permitting the mounting of counter-balances significantly closer, thereby greatly reducing polar moments of inertia. Gear trains and related electronics are completely enclosed—providing protection from weather, fouling, corrosion, breakage, etc. Up to 810° of travel are available without slip-rings for non-rotational tracking and slip-ring models are available for all around tracking capability. (Canoga has developed the Tri-Ped antenna which provides complete flexibility by the addition of a third, or traverse, axis to the conventional azimuth and elevation axes.)

A single stowing lock secures both elevation and azimuth gears and disengages servos in one operation. Elevation of 200° permits "plunging" for boresight purposes.

Canoga pedestals offer compact, double planetary, interchangeable drive modules with eccentric backlash adjustment, modular interchangeable data packages, balanced elevation yoke which eliminates eccentric loading of the azimuth bearing, yielding increased high-elevation angle accuracy and minimizing the perpendicularity problem. Also, a synchro-torque transmitter hand-wheel follow-up feature eliminates unexpected pedestal accelerations when switching from the slaved to local mode of operation.

Canoga pedestals can accommodate paraboloidal dish antennas up to 28' in diameter and various helix arrays.

Standard bolt circle and bolt dimensions provide for adaptability to standard mounts or mounting can be engineered to customer specifications.

Canoga Electronics Corporation also manufactures complete radar systems, microwave ferrite devices and components, radar and telemetry antennas, radar reflectors, range instrumentation, test equipment and special electronics equipment to customer specifications.

canoga

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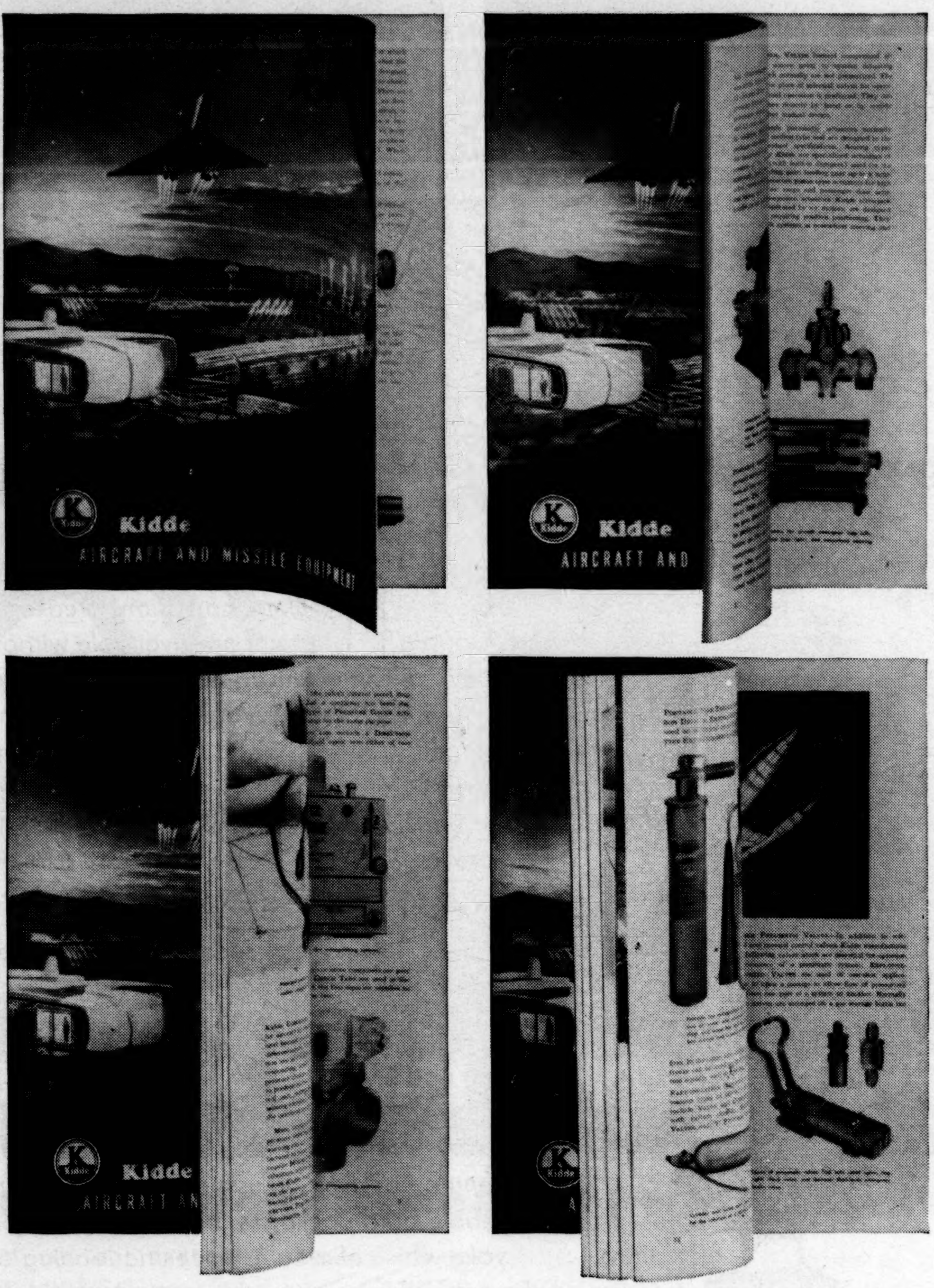

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AVIATION CALENDAR

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tures, Materials & Design, American Rocket Society, Palm Springs, Calif.

Apr. 4-7—National Aeronautic Meeting, Society of Automotive Engineers, Commodore Hotel, New York, N. Y.

Apr. 10-11—Spring Meeting, Western States Section/The Combustion Institute, Aeronutronic Division of Ford Motor Co., Newport Beach, Calif.

Apr. 10-14—International Symposium on Aviation Research and Development, Federal Aviation Agency, Atlantic City.

Apr. 13-14—Annual Meeting, National Aeronautical Services Assn., Hotel Washington, Washington, D. C.

Apr. 13-14—Institute of the Aerospace Sciences/Army Aviation Meeting (classified), Washington, D. C.

Apr. 17-28—14th Technical Conference, International Air Transport Assn., Queen Elizabeth Hotel, Montreal, Canada.

Apr. 18-20—Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute, Mark Hopkins Hotel, San Francisco, Calif.

Apr. 20-22—General Meeting, American Meteorological Society with the American Geophysical Union, Washington, D. C.

Apr. 22-25—Annual Business Meeting and Conference, American Assn. of Airport Executives, Broadmoor Hotel, Colorado Springs, Colo.

Apr. 24-27—32nd Meeting, Aerospace Medical Assn., Palmer House, Chicago.

Apr. 26-28—Liquid Rockets, Propellants and Combustion Conference, American Rocket Society, Palm Beach Biltmore, Palm Beach, Fla.

Apr. 30-May 4—Seventh National Aerospace Instrumentation Symposium, Instrument Society of America, Adolphus Hotel, Houston, Tex.

May 3-5—17th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 3-5—Nuclear Applications in Space Conference, American Rocket Society/Oak Ridge National Laboratory, Gatlinburg, Tenn.

May 8-10—National Aerospace Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio.

May 9-11—Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles, Calif.

May 12-14—Mid-America Air Fair, Municipal Airport, Wichita, Kan.

May 15-17—National Symposium on Microwave Theory and Techniques, IRE, Sheraton Park Hotel, Washington, D. C.

May 15-18—20th Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Hotel, Akron, Ohio.

May 22-24—National Telemetering Conference, Sheraton-Towers Hotel, Chicago, Ill.

May 22-24—Fifth National Symposium on Global Communications, Institute of Radio Engineers, Hotel Sherman, Chicago.

May 26-June 4—24th French International Air Show, Le Bourget, Paris, France.

July 25-Aug. 10—International Trade Fair and Aviation Exhibition, McCormick Place Exposition Center, Chicago, Ill.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

March 6, 1961

Aviation Week and Space Technology

Vol. 74, No. 10
Member ABP and ABC

EDITORIAL OFFICES: New York 36—330 W. 42nd St., Phone: LOngacre 4-3000 (Nights LO 4-3035) **Washington 4, D. C.**—National Press Bldg., Phones: NAtional 8-3414, REpublic 7-6630 **Los Angeles 17**—1125 West Sixth St., Phone: HUntley 2-5450 **Dallas 1**—1712 Commerce St., Phone: RIverside 7-9721 **European Office**—1 rue du Temple, Geneva, Switzerland, Phone: 32-35-63

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▶Proposed change would give development of payloads almost exclusively to Air Force; Army, Navy object.

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▶Eastern will take monthly delivery of balance of its 39-aircraft fleet of Super Electras through July.

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COVER: USAF-Martin Titan intercontinental missile is launched from Air Force Missile Test Center carrying a General Electric Mark 3 re-entry vehicle for the first time (AW Feb. 20, p. 29). Missile is a J model, prototype of the Titan I operation version. Operational Titans will carry the heavier Avco Mark 4 nose cone but interchangeability of the cones is a requirement of the missile program. Two more flights of Titans equipped with the Mark 3 were planned. The GE cone will be used on a number of operational Atlases.

PICTURE CREDITS

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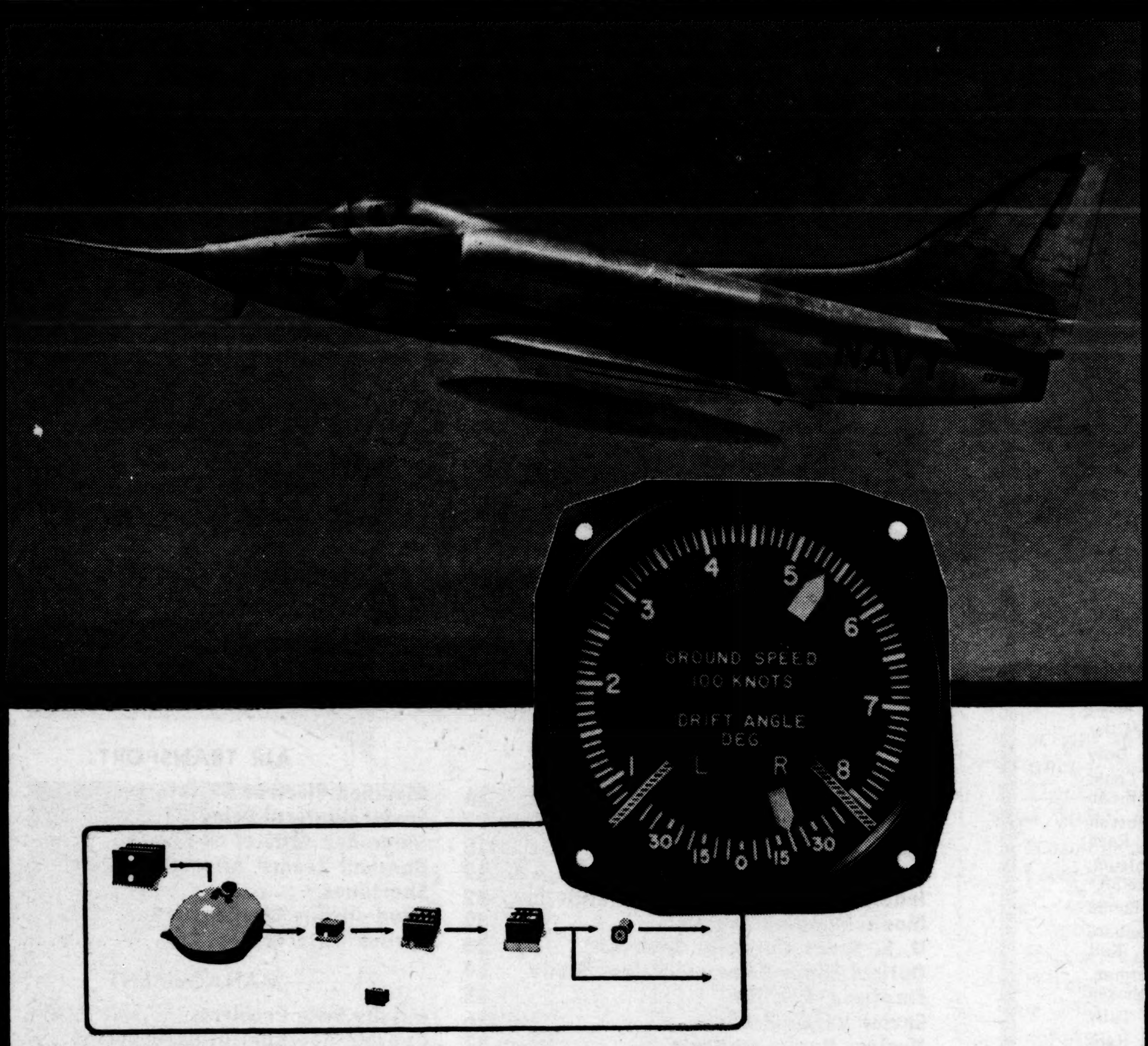
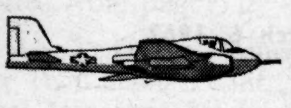


AIRCRAFT ALREADY USING RYAN APN-122(V) NAVIGATOR



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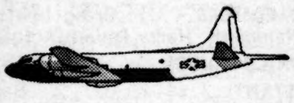

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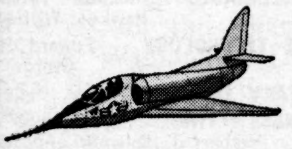

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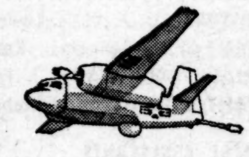

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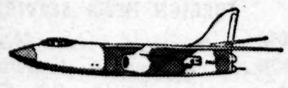

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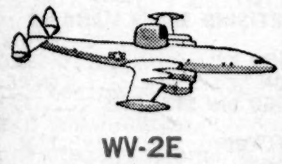

WV-2E

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Adaptable for nearly every type of aircraft, the Ryan APN-122(V) continuous wave Doppler system provides instantaneous and continuous display of ground speed and drift angle *in all weather* without reliance on ground or celestial aids. Here are some of the advantages that make this Ryan radar system the most advanced, *proven* means of aerial navigation.

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- Has no altitude or attitude holes.
- High accuracy (within ½%) at all altitudes from 0 to 70,000 feet, and over seas even smoother than Beaufort 1.
- No minimum altitude. Operates during take-offs, landings and turns.
- Operates in the **approved** frequency range (13.25-13.40 kmc/s).
- Speed ranges: 80-1000 knots; and 120-1600 knots.
- Fixed (non-gimballing) antenna.
- Outputs suitable for damping inertial sets.

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EDITORIAL

Spotlight on Bioastronautics

The vital field of bioastronautics moved into the Capitol Hill spotlight last week with the publication of a report by Rep. Emilio Q. Daddario (D.-Conn.) of the House Science and Astronautics Committee and with the National Aeronautics and Space Administration's disclosure of its rapidly expanding program in this area.

This spotlight on bioastronautics is significant for several reasons:

- **This is a field where there has been considerable** government and scientific reluctance to acknowledge its importance as a foundation for all manned exploration of the interplanetary system as well as for manned military space missions. Consequently, it is an area in which we are lagging badly behind Russian achievements.
- **It offers another test of whether the government** can effectively gear its administrative and executive machinery to organize all available resources in this field into an effective national program that is not only required for our own national goals but will eventually benefit all mankind, or whether these resources will once more be dissipated in bureaucratic duplication, inter-departmental credit-snatching and consequent imposition of an insupportable financial requirement.
- **It is also symptomatic of the continuing conflicts** NASA has encountered with both civil and military organizations that already were working successfully in its fields before its 1958 transformation from the old National Advisory Committee for Aeronautics. It raises again the question of whether NASA should really continue as an operating agency with all-encompassing responsibility for space, or whether it should revert to the status of a basic exploratory research organization whose activities primarily reflect the needs of both the military and civil groups with requirements to operate useful space systems.

Nobody concerned with the space program objects to NASA organizing, as it did last year, a small life sciences group to develop in-house competence to monitor and stimulate progress in this area. The current objections, raised from a variety of sources, are based on NASA's apparent intention to build a research empire with little regard for the facilities and talents already available in this field and on NASA's denial that any such capability exists in the military services beyond bioengineering. These objections are also bolstered by the suspicious trend that, as NASA's expansion in this area begins, other agencies long established in the field find their programs diminishing and detect considerable top level NASA pressure to exclude them from future participation and program planning.

It is a matter of record that NASA is an extremely late arrival to this field. The Air Force, Army and Navy began space biology experiments with animals ranging from fruit flies to dogs and monkeys in 1947 with high altitude rockets and balloons. A formal space biology laboratory was established by USAF in 1952 at Holloman AFB in New Mexico. It is also a matter of record that NASA's Project Mercury has been almost 100% reliant on the Air Force and Navy bioastronautics facilities and capabilities for training the Astronauts and developing their special equipment.

Rep. Daddario has compiled a comprehensive list of Army, Navy and Air Force facilities already working far beyond the bioengineering capability that NASA claims marks the limits of their abilities. Not the least of this input has come from European scientists enlisted in the program by the Brussels office of Air Research and Development Command and the London unit of the Office of Naval Research.

Against the background of this report Rep. Daddario offers some pertinent recommendations, of which the most significant perhaps are:

- **Study should be made of all life sciences** activities contributing to the national space program, including policies, plans and accomplishments of all agencies engaged in such activities.
- **Central authority should be established** to formulate a comprehensive program of life sciences to be conducted by the agencies of the U.S.
- **This central authority would review** and validate objectives and establish requirements for space-oriented basic and applied life sciences research directed to both military and civilian goals. Such authority should assign primary responsibility for this research with a view toward maximum use of existing resources.
- **In the interest of a more efficient** utilization of our capabilities to accomplish national space goals, NASA should be enjoined from further expansion of its life sciences research effort until the recommended studies are completed, a coordinated program established and responsibilities delineated.

The role of man in space has been the most difficult aspect of the space research program to sell the scientific community. There is still a large group of scientific conservatives well entrenched in key government desks and committees who scoff at the idea of man performing any useful function in space and who fight against the expenditure of any funds to lay the scientific foundation for such an enterprise.

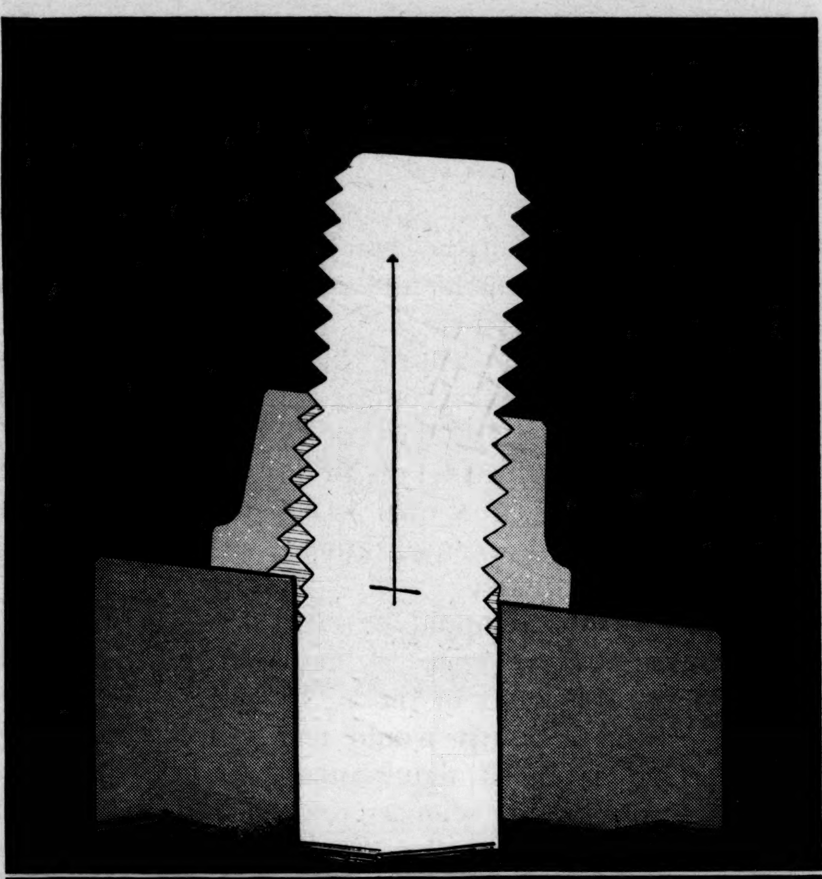
We respectfully suggest that they will soon find themselves in the unenviable position of those who scoffed against the whole idea of space technology before Sputnik I. The impact of the first successful Soviet Cosmonauts and the psychological effect of having Soviet spacemen orbiting over the U. S. will create a public furor that will make the Sputnik panic pale in comparison.

However, in addition to this tremendous psychological effect, against which the reedy voices citing more voluminous U.S. scientific papers on space will hardly be heard, there is a scientific challenge of incredible magnitude in expelling man from his earthly atmospheric envelope and freeing him to explore the wonders of the universe.

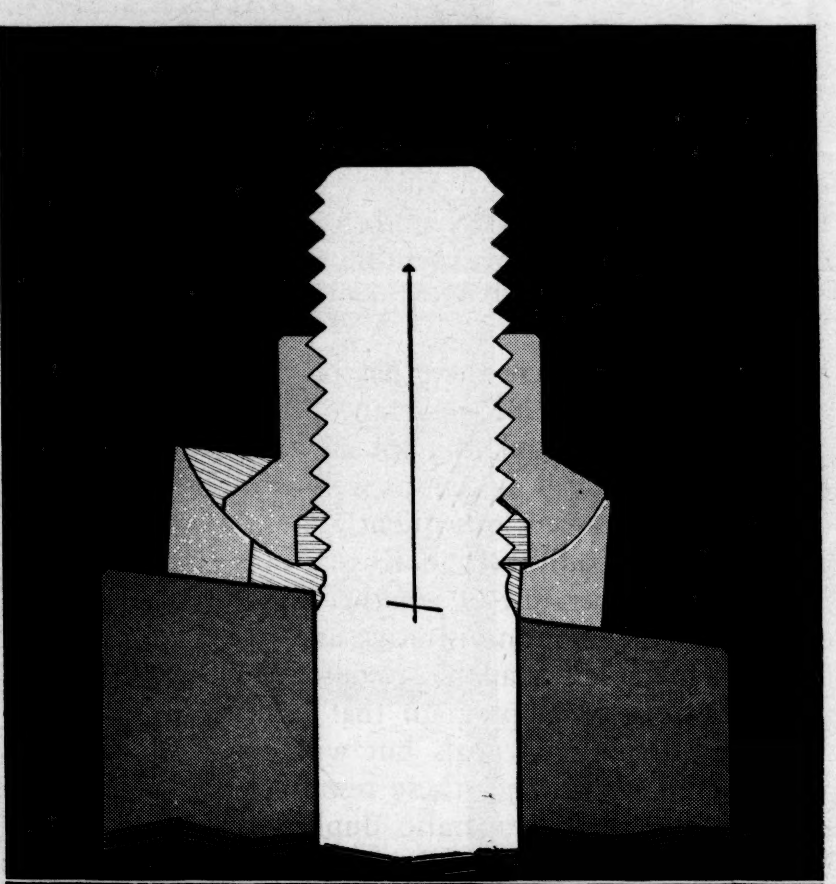
The problems of organizing a sound and effective national bioastronautics program should receive serious consideration from Congress, the National Aeronautics and Space Council, when it becomes effectively organized, and the President himself, for it is the foundation on which man's eventual exploration of the universe must be built.

--Robert Hotz

Maintains full fatigue strength to 8° misalignment . . .

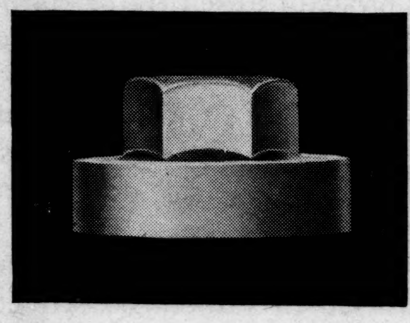


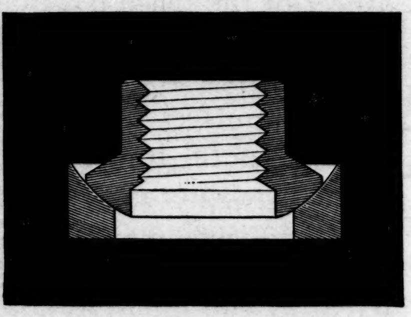
Bend in bolt is clearly apparent with an out-of-square condition of 8°.



Note how SPS Self Aligning Washer keeps nut perpendicular to bolt shank.

SPS Self Aligning Nut





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WHO'S WHERE

In the Front Office

L. C. Mallet, a director, United Technology Corp., Sunnyvale, Calif. Mr. Mallet is vice president of United Aircraft Corp., and general manager of Pratt & Whitney Aircraft Div.

Herman J. Abs, board chairman, Lufthansa German Airlines succeeding **Dr. Kurt Weigelt**, retiring.

Dr. Leland I. Doan, a director, The Bendix Corp., Detroit, Mich. Dr. Doan is president of The Dow Chemical Co.

Franklin B. Lincoln and **Dr. Wallace R. Brode**, directors, Barnes Engineering Co., Stamford, Conn. Mr. Lincoln is president of Monroe Calculating Machine Co. and vice-president of Litton Industries, Inc.; Dr. Brode formerly was scientific advisor to former Secretary of State Herter.

Space Technology Laboratories, Inc., Los Angeles, Calif., has appointed the following as vice presidents: **Dr. Adolf K. Thiel**, director, Space Systems Program Management and acting director of the new Fabrication, Integration and Test Division; **Dr. Robert R. Bennett**, program director, Minuteman weapon system; **Dr. W. S. Carlson**, director, STL Electromagnetic Systems Division, Canoga Park, Calif.

George T. Cussen, vice president-interline air freight development, The Flying Tiger Line.

Frank W. Lehan, executive vice president, Space Electronics Corp., Glendale, Calif.

Dr. George Krsek, executive vice president and general manager, International Rectifier Corp., El Segundo, Calif.

Robert R. Beachler, Jr., vice president, Leach Corp., Los Angeles, Calif., and general manager of Leach Relay Division.

Dr. Ernst M. Huttrer, executive vice president, Intercontinental Electronics Corp., Westbury, N. Y., and **Leonard Goldman**, a vice president.

John L. Pennewell, executive secretary, Helicopter Assn. of American; the Assn. has established national headquarters in Washington, D. C.

Honors and Elections

Bernard A. Schmickrath, engineering manager of Pratt & Whitney Aircraft Division of United Aircraft Corp., has been elected chairman of the Propulsion Technical Committee, Aerospace Industries Assn., replacing **Chandler C. Ross**, vice president-engineering, Aerojet-General Corp.

Changes

Scott Crossfield, director of space and missile system test, Space and Information Systems Division, North American Aviation, Inc., Downey, Calif. **Al White** succeeds Mr. Crossfield as chief test pilot of the company's Los Angeles Division.

Harold D. Germann, manager-government operations, Thiokol Chemical Corp.'s West Coast District Office, El Segundo, Calif.

Robert W. Mayer, manager-engineering, General Electric Co.'s Ordnance Department, Pittsfield, Mass.

(*Continued on page 92*)

INDUSTRY OBSERVER

▶ Little Joe, Atlas, Atlas Agena and Saturn vehicles all are scheduled to launch Apollo models and capsules on development flights. The earth-orbiting version of Apollo will weigh 9-15,000 lb., and the lunar orbiting version will weigh 15-20,000 lb.

▶ **Thin slab of phenolic nylon, a potential protective material for re-entering space vehicles, withstood 9,000F in a 105-sec. run during a recent series of National Aeronautics and Space Administration tests.**

▶ Watch for the Marine Corps to be assigned the mission of close air support for Army ground forces, using the Douglas A4D light attack aircraft.

▶ **Flight testing of the ramjet-powered North American Roadrunner target drone was scheduled to begin last week at White Sands Missile Range. Approximately six flight tests are planned, following successful tests of full-scale wooden dummy versions.**

▶ Wright Air Development Division plans to select an airframe study contractor for Project Slam in mid-April, following submission of proposals early this month by Chance Vought, Convair and North American. Main contractor task will be to analyze configuration, structural aspects and performance characteristics of the supersonic low-altitude missile, which is to be powered by the nuclear ramjet Marquardt is developing under Project Pluto.

▶ **Israel Aircraft Industries has built a full-scale mockup of its proposed twin turbojet executive aircraft (see p. 87). The aircraft has a T-tail with horizontal stabilizer and elevators mounted on top of the vertical tail. The company plans to build two prototypes and a static test airframe.**

▶ Convair-Astronautics, working under an accelerated timetable, is asking for bids by March 16 on Atlas site activation at Lincoln, Neb., and Altus, Okla., Air Force Bases. Contracts probably will be awarded by May 1, and might run about $12-15 million per site.

▶ **Air Force Ballistic Missile Division is planning to develop radiation measuring satellites to be launched piggy-back on Midas infrared early warning satellites. The program calls for about 10 such units.**

▶ Schedules may slip in three Army missile programs—Shillelagh, Redeye and Hawk—unless additional money is provided in the current fiscal year. Army is $28 million short of covering program cost increases.

▶ **Air Force has developed an ultraviolet altimeter for use on aircraft operating at altitudes up to 125,000 ft.**

▶ Industry proposals on specifications, preliminary design and support equipment for a battlefield ballistic missile system are to be submitted to the Army late this month. Requirements call for a short-range, single-stage, solid propellant missile.

▶ **Air Force plans to have a 135-man staff at Wright Air Development Division by March 15 to administer the SS-476L cargo jet transport program. Convair, Lockheed and Douglas all are proposing basically similar designs, with a high wing and four turbofan engines.**

▶ Air Force has developed an ophthalmic filter to control transmission of light energy. The device will protect the eyes of pilots of space vehicles but will permit optimum cockpit visibility.

▶ **Lockheed Aircraft Corp. proposal in the Army light observation helicopter competition features the unconventional control system the company has been testing in its prototype light helicopter. Current test vehicle was rebuilt from the wreckage of the original prototype which crashed. Boeing-Vertol entry in the LOH competition, the Model 131, is a conventional single rotor helicopter.**

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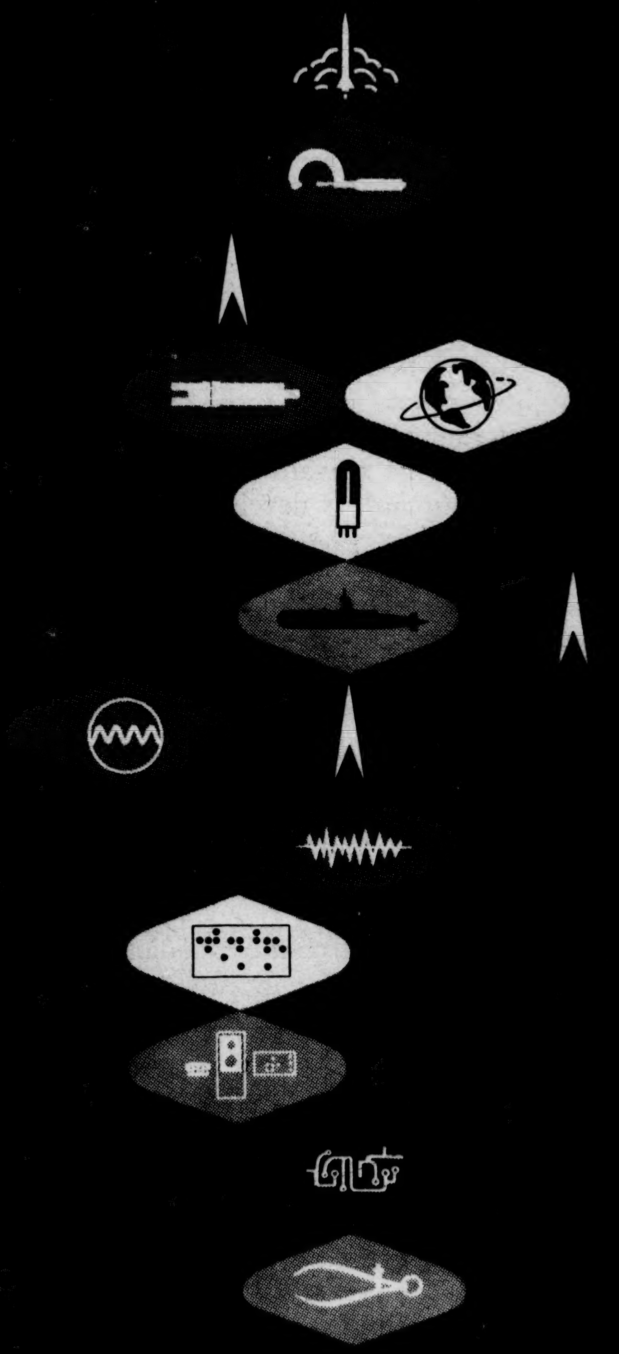

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Washington Roundup

Plugging the Leaks

President Kennedy has lost all patience with information leaks and public statements that serve one government agency at the expense of another. More investigations are under way now than at any time in recent years, and word has been passed through the executive branch that severe action will be taken with offenders.

Latest major flap is over a report that Secretary of State Dean Rusk had advised Defense Department that the U. S. should shift away from automatic reliance on nuclear weapons (see p. 31).

Most of the recent trouble has concerned the four panels that reviewed the defense structure. Defense Secretary Robert McNamara originally ordered them to hold information closely. When leaks began to appear in print about three weeks ago, he reaffirmed his orders.

Leaks continued. McNamara quit using military investigative agencies and switched to civilian sleuths. When the Rusk story broke, McNamara called in the secretaries and military chiefs of the three services for reprimands. He suspected Air Force but made his criticism general and ordered retroactive investigations of earlier leaks. Army also is in his doghouse because of the outburst of support for the Nike Zeus anti-missile missile in congressional speeches.

One of the most prevalent rumors concerning the panels' work was that the research and engineering group had recommended cutting the North American B-70 bomber back to a small research and development effort, where it had been before Congressional pressure last summer got it reinstated as a weapon system development.

Sen. Clair Engle (D.-Calif.) said in a Senate speech that the Eisenhower Administration released $155 million of the $190 million extra voted for the B-70, but said the remainder has not been used. He said another $100 million voted for either fighters or the B-70 also has not been used. Without referring to the panels, he said "the drift of events" is causing "renewed apprehension over this vital defense weapon."

Air Force plans for a public showing of the Boeing B-52 and the Avro Vulcan bombers fitted with Douglas Skybolt missile dummies were canceled recently by Defense to avoid the appearance that the service was promoting the weapon system while the defense structure was under review.

Technical Data Bars

Two industry witnesses gave the Congressional Joint Atomic Energy Committee directly conflicting testimony last week on the merits of restricting technical information on nuclear materials development. Dr. Joseph W. Sausville, manager of Curtiss-Wright's ceramic materials department, said materials scientists in nonclassified projects are equally as bright as those working under security restrictions, creating a danger that "a significant advance or breakthrough . . . will be revealed outside the protective custody of security." He suggested classifying materials work done on unclassified projects as "Confidential Restricted Data."

Dan Kimball, president of Aerojet-General, told the same committee that excessively restrictive use of government security regulations sometimes prevents "the rate of progress from being as great as is possible and desirable." He said materials development and fuel element research are examples of "such over-protection." Kimball recommended revision of security practices to allow greater freedom of information exchange and adoption of a single set of security rules for all government-industry programs, and he said similar recommendations made to the Commission on Government Security five years ago "are still not implemented."

House space committee is considering investigating government use of non-profit organizations such as Aerospace Corp., Mitre Corp. and Institute for Defense Analyses.

New Space Post

A special assistant for space will be named by Dr. Herbert York, defense director of research and engineering. The position later will be expanded into a technical office. Rear Adm. Charles B. Martell, former assistant chief of naval operations for development, will take the new job of director of administration under York. Albert W. Blackburn has moved from special assistant to the assistant director for strategic systems to the position of deputy assistant for tactical systems. Lt. Gen. Donald N. Yates, former Air Force Missile Test Center Commander and now York's deputy for ranges, retires Mar. 31.

International Astronautical Federation officials are meeting in Paris to attempt to remove from their constitution the possibility that Russia could exercise veto power over projects it disliked.

Chairman Oren Harris of the House commerce committee is establishing a permanent subcommittee on Civil Aeronautics Board and other regulatory agencies.

—Washington Staff

USAF May Gain Stronger Role in Space

Proposed change would give development of payloads almost exclusively to Air Force; Army, Navy object.

Washington—Proposed Department of Defense directive that describes space technology as primarily the interest of the Air Force appears to strengthen USAF's already dominant role in military space. It allows Army and Navy to develop payloads only by exception.

The proposal, which drew objections from the Army and Navy, was sent to the three services, the chairman of the Joint Chiefs of Staff and other Defense offices on Feb. 23, with a deadline of Mar. 2 for concurrence or comment, by Defense General Counsel Cyrus S. Vance.

If it goes into effect the directive would place Director of Defense Research and Engineering Herbert F. York in a stronger position than before in his control of military space activities. Since September of 1959, Dr. York's office has assigned most of the space projects formerly directed by the Advanced Research Projects Agency to the Air Force.

The new order is intended to take the place of one signed by former Defense Secretary Neil H. McElroy on Sept. 18, 1959 titled "Satellite and Space Vehicle Operations."

Although the document was forwarded by the general counsel, it actually was the first major effort of the special office on defense management created by Secretary of Defense Robert S. McNamara. Solis Horwitz heads the office and reports to the general counsel.

The revised directive is titled "Development of Space Systems." It establishes policy for assigning responsibilities for research, development, test and engineering and satellites, anti-satellites, space probes and supporting systems.

Dual LOH Production

Washington—Army will choose two contractors to produce its light observation helicopter (LOH), and selection of the two winners in the competition is expected in May.

The LOH program is expected initially to call for production of 2,250 helicopters under the dual production plan. If the Army eventually replaces all of its L-19s, H-13s and H-23s, the program could total 3,500 aircraft.

Proposals for the project, submitted Jan. 31, are being evaluated by two Army teams—one at the Army Aviation Board, Ft. Rucker, Ala., and the other at the Bureau of Naval Weapons, which is responsible for supervising technical aspects of the project and for buying the helicopters for the Army.

The Army Aviation Board team is consulting all commands and schools interested in the LOH, including infantry, cavalry and artillery elements. The helicopters produced by the two contractors probably will be designated YHO-4 and YHO-5.

An offensive mission for the Air Force is implied by the use of the term "anti-satellite." Space technology is treated as a military mission rather than a scientific discipline, which was the theme of the McElroy directive.

Army, Navy Views

Army and Navy, having aired their objections to Air Force domination of space programs in Congress last week (AW Feb. 27, p. 25), now are continuing their fight within the Pentagon.

Indications are that if they are unsuccessful in pressing for joint service efforts in space inside Defense and the Administration, they will take their cases to Congress again.

Navy Secretary John B. Connally, a close friend of Vice President Lyndon B. Johnson, will be especially active in supporting the views of his service within the Administration. Johnson was formerly chairman of the Senate space committee and now is being proposed in new legislation as the head of the National Aeronautics and Space Council.

Although recognizing that each of the other military services and agencies of the Defense Department have a substantial interest in this area, the directive says that the Air Force has the primary interest in space technology.

It places on the Air Force responsibility for the development, production and launching of space boosters, systems integration and development of payloads for satellites, anti-satellites, space probes and supporting systems.

Exceptions to Rule

All exceptions to this policy will be made on the recommendation of the Director of Defense Research and Engineering by the Secretary of Defense. Previously, Air Force has had the booster and systems integration assignments and most of the payload work, but the other two services have not been excluded from payload development as completely as they seem to be now.

Special capabilities of another department or agency or a direct project relationship will be taken into account in making exceptions for Army or Navy.

If one department or agency is assigned responsibility for developing a satellite payload and another the responsibility for the booster, an over-all project manager would be selected by Dr. York's office. If the manager is any service other than Air Force, terms of the assignment must be approved by the same office.

Dr. York's office is given authority for approval of all space research and development projects or programs. Systems study efforts would also be kept under tight concept and budgetary control by that office.

The directive spells out arrangements for reimbursement between services and agencies for boosters, equipment and facilities. Each service or agency will be responsible for budgeting for its own space programs.

Monopoly Feared

Concurrences or comments received Mar. 2 ranged from acceptance by the Air Force to mild objection by the Army and stronger comments by the Navy.

Basic arguments presented by the Army and Navy center around what would result if the Air Force had a monopoly of space. They claim that their interests would not be served because of disinterest and neglect.

An example given was that of the airplane, whose proponents within the Army had to fight for years before it gained recognition as the major weapon. Another example is that of radio communications, pioneered by the Navy in shore-to-ship applications.

It is argued that if either system had been assigned exclusively to one service as the most economical procedure, it is probable that requirements of the other services would not have been served.

Fear was expressed by both Army

New Funds For Skybolt

Washington—Defense Department is considering a reallocation of funds for Air Force-Douglas Skybolt development that would provide $236 million to continue the project through June, 1962, compared with $150 million under current budget plans. This new spending schedule is expected to introduce slippage of about seven months behind the operational target date for the missile, bringing it to October, 1964.

and Navy about long-range effects—not what might happen to projects that will become operational in the near future such as Army's Advent communications satellite and the Navy's Transit navigation satellite.

The Army, assigned the map-making mission for the Defense Department, is concerned about possible erosion of its role in geodetic satellite projects, even to eventual loss of the mapping responsibility.

The Navy, with "economy" approaches to launching satellites into equatorial orbits and to destroying satellites with vertical rising "space mines," is sure that its concept of covert sea launching would be ignored by the Air Force.

Additional arguments were presented which stated that the proposed directive assumes that the Air Force is best qualified in all respects to develop boosters and payloads and ignores the older scientific capabilities of the Army and Navy. Both argue that it would be a waste of talent and money to bypass this pool of research, researchers and procurement management.

The job of surpassing the Russians, they say, requires all the talent and ideas the United States can muster.

The claim was made that the directive implies that the booster is the most important factor in space systems. This is the same sort of thinking, the objections said, as considering the bomb bay of the airplane more important than the nuclear weapon it carries, or the idea that the mission of military airlift is to fly transport aircraft.

So much attention has been paid to the booster, it was argued, that solution of this problem has become the objective of astronautic effort to the detriment of the payload. The booster is the means to the end, and the payload counts as much or more than the boosting vehicle.

The original McElroy memorandum was based on a presumption that the number of satellites to be launched in the next few years would be small, it was stated.

The new proposal, the objections claimed, carries on this idea, even though 43 satellites or pieces of rockets are now in orbit, with indications that before long space launchings will increase to the rate of one a day.

NASA-Military Life Science Fight Spotlighted by Daddario Report

By Evert Clark

Washington—Fight between the military services and the National Aeronautics and Space Administration over control of bioastronautics broke into the open last week as the result of a congressional report urging that expansion of NASA's life sciences work be halted until a central authority can be created to direct a coordinated national program.

Principals in the struggle are National Aeronautics and Space Administration's Office of Life Science Programs and Air Force's Air Research and Development Command, although other elements of USAF and the Army and Navy are involved.

The fight began with the creation of NASA and the transfer of USAF's man-in-space program to the new agency in October, 1958. It has increased in intensity since NASA established the life sciences office in March of last year (AW Mar. 7, p. 327).

Although all three services are supporting NASA's programs and have expanded in some areas in order to do this, each has found other aspects of its life sciences work curtailed, halted or brought under NASA's control.

The 43-page report that finally may concentrate enough attention on the situation to force a solution was made by Rep. Emilio Q. Daddario (D.-Conn.), member of the House Science and Astronautics Committee, to Chairman Overton Brooks (D.-La.).

Rep. Daddario urged that:

- **A study be made** immediately of all life sciences work concerned with space.
- **A single military** bioastronautics program be formulated, possibly under one service as the executive agent.
- **A central authority** be established to formulate a comprehensive national life sciences program.
- **NASA be "enjoined** from further expansion of its life sciences research efforts" until the new national program was established.

Rep. Daddario also recommended that the President "take cognizance of the question of research in the life sciences as having progressed beyond the point of orderly and single development, and that he direct the [National Aeronautics and] Space Council to make this issue one of immediate attention."

The Kety report, a special survey of national life sciences resources that led to establishment of NASA's life sciences office, recommended a year ago that NASA become "the nucleus of a national undertaking" similar to what Rep. Daddario now proposes for his unspecified "central authority."

The Kety report said national space biomedical work outside of NASA's Mercury man-in-space program—that is, in military, industrial and academic laboratories—was "sporadic and incidental to primary interests or responsibilities." It said this work was "on the whole, of excellent quality and should be maintained and supported" but said it should be coordinated with "a broad and thoughtfully planned biomedical program of research extending from the most fundamental aspects to their most practical applications."

Rep. Daddario said the Kety report "treated only briefly existing life sciences resources within the armed services and its implied purpose was to ensure that biological, medical and behavioral divisions were 'adequately' represented in NASA."

Both the House and Senate space committees questioned NASA closely last year about possible duplication of or conflict with life sciences work already under way in military laboratories, and, in effect, warned NASA not to err in either direction.

NASA said it intended, at least initially, to develop only enough in-house capability in biosciences and bioengineering to coordinate and stimulate life sciences programs in existing university, industry and government laboratories. It said it did not expect to annex any existing facilities, as it had in the booster field with some Army missile facilities at Huntsville, Ala.

Committee Query

The House committee also questioned the three services on the idea of a NASA life sciences office. None gave it enthusiastic support but none opposed it strongly enough to keep it from being established.

Although one of Rep. Daddario's main points was that the services have the capability—and the need—to do biosciences work as well as bioengineering, most of the friction between the services and NASA over what is and isn't being done actually has come in the bioengineering and operating areas rather than in research.

The Kety report urged NASA to "initiate shortly and project indefinitely" a satellite and probe program in which "a significant number of payloads would be dedicated primarily to biomedical purposes."

NASA still has not initiated such a program, although Dr. Clark Randt, chief of the life sciences office, told the Senate space committee last week that four orbital launchings of Mercury capsules carrying monkeys and a chimpanzee have been proposed and have tentative approval from NASA.

Each capsule would be launched by an Atlas and each would contain a restrained chimpanzee, a restrained monkey and an unrestrained monkey. Flight times would range from 18-20 hr. to 14 days. Randt said this plan has been developing over the past six months. He said Army's Walter Reed Research Institute, Atomic Energy Commission, NASA's Goddard Space Flight Center, University of California's Berkeley and Los Angeles campuses and the Florida State University would participate and said the program is being coordinated with Defense Department.

NASA has not yet determined where it will get the animals. It has no supply of its own. All three services have provided animals for other space tests.

Primary purposes are to study the combined effect of various stresses on the animals' ability to perform complicated tasks during extended weightlessness.

Col. Charles H. Roadman, a USAF command pilot, chief flight surgeon and Dr. Randt's special assistant since last June, was named last week as deputy director of the life sciences office.

Air Force, which last fall began accelerating its bioastronauts research (AW Oct. 24, p. 26), recently proposed to NASA a joint five-year USAF-NASA program centering around experiments with animals in space. NASA did not accept the plan, and Air Force is expected to go ahead by itself.

There has been considerable unrest in the services and in the aerospace industry at the lack of biosciences research and experimentation being done by the United States. NASA did not even begin to build its own biosciences capability until last year, and none of the services has had a clear mandate to conduct a broad program.

Space Program to Be Reshaped Without Major Budget Increase

By Edward H. Kolcum

Washington—Kennedy Administration is reshaping the civilian space program by shifting emphasis among projects, but it is unlikely that the program will be given any substantial increase in money over the Eisenhower budget request.

James E. Webb, administrator of the National Aeronautics and Space Administration since mid-February, told the Senate Committee on Aeronautical and Space Sciences last week that there will be some changes and revisions in the Fiscal 1962 NASA program developed under President Eisenhower, which called for expenditures of $1.12 billion (AW Jan. 23, p. 29).

Program review was ordered by President Kennedy (AW Feb. 20, p. 25), and Webb told the committee the President regards the review as essential and "will insist that any changes he initiates will represent a hard-boiled appraisal of our true national interests and will fit in the framework of total national policy."

Webb said he expects the new program will be on a "solid basis" by the time the authorization hearings are completed. The House space committee will begin its authorization hearings Mar. 14 and is scheduled to report by Apr. 4.

Indications are that Webb will have a difficult time increasing the total NASA budget over the amount submitted by the Eisenhower Administration. Changes apparently will be responsive to congressional desires for more urgency in launch vehicle and planetary spacecraft development.

The NASA administrator conferred with Budget Director David E. Bell Feb. 17 on large booster, Mars and Venus projects which scientists in the agency recommended be accelerated. Because of Webb's recent arrival in the post, and because the proposals represented only a partial review, he made no recommendation to Bell and was not in a position then to justify any increases.

Budget Bureau reportedly has ruled against any increase in the $1.12-billion space expenditure for Fiscal 1962 unless the funds are essential for security.

In conducting his current review, Webb has met with Dr. Glenn T. Seaborg, Atomic Energy Commission chairman, and Defense Secretary Robert S. McNamara.

Webb described the prospect of changes to begin what was basically a primer session on the NASA programs for the Senate space committee, headed by Sen. Robert S. Kerr (D.-Okla.). Chairman for the previous two years was Vice President Lyndon B. Johnson.

Two-day hearings, the first before the full committee, were based on objectives set by the previous Administration.

Under committee questioning, Dr. Robert C. Seamans, Jr., associate NASA administrator, said assessment of Soviet claims of heavy payloads is made by the Central Intelligence Agency, based on its own calculations and estimates and on information obtained from NASA and other agencies.

Maj. Gen. Don R. Ostrander, NASA launch vehicles director, said it is possible to estimate the size of a space vehicle from the size of its cross section radar return, and Dr. Robert Jastrow, chief of the agency's Theoretical Division, said weights of low-orbiting satellites can be estimated by orbital changes when the satellites are closest to earth. Both Sputniks VII and VIII were in low orbits of about 120-190 mi.

Highlights of the presentations:

- **Lunar program:** The Surveyor soft lunar landing vehicle, to be launched in mid-1963, may be followed by a lunar satellite in a precise 100-300 mi. orbit. Unnamed project would use Centaur to launch the satellite, which would sample the atmosphere and photograph the moon's surface. Later, the mobile prospector could travel several hundred miles over the lunar surface and pick areas of greatest interest and hazard for manned flights.
- **Space sciences:** Satellites, sounding rockets and probes are being used and planned to study the earth as a planet and its atmospheric properties, influence of solar weather, origin and properties of moon planets, stars, galaxies.
- **Project Mercury:** Ballistic flight of the chimpanzee Ham erased fear that man would choke on his stomach contents while in weightless flight. Eleven production capsules have been delivered of 24 under production at McDonnell Aircraft. McDonnell and Mercury personnel at Atlantic Missile Range are on three-shift, seven-day work weeks.
- **Weather satellites:** Two additional Tiros satellites will be launched in an effort to keep a weather satellite aloft continuously. Two Nimbus satellites will be launched in 1962, with a 6-9 mo. firing interval, and two more will follow in 1963. No research and development on the third generation Aeros is planned until next year. Weather satellite research is coordinated by nine separate boards, panels and committees.
- **Universities:** They are selected for participation in NASA projects on the bases of experience and interest. Selection is made by the Space Sciences Steering Committee on advice of the National Academy of Sciences, scientific consultants, and NASA scientists.

Dr. Hugh L. Dryden, deputy NASA administrator, said the agency's international policy represents "true cooperation" because it does not involve hiring foreign scientists but is a method by which other countries can develop their own programs.

The number of nations with satellite programs has grown from only the U. S. and USSR in two years to include Britain, Canada, France and Japan, he said. A Japanese mission is now visiting NASA laboratories, and all nations but Russia are basing their programs on NASA launch vehicles and support.

Bold Action Is Urged on Nuclear Rockets

By Ford Eastman

Washington – Development of nuclear rocket propulsion systems should become a major national effort because they will provide the key to future space exploration, government, military and industry representatives told Congress last week.

Although the research and development costs alone will run into hundreds of millions of dollars, they said it is essential that deliberate, but bold action should be taken now to assure U.S. supremacy in space exploration.

The Project Rover nuclear rocket propulsion program is under review by the House Committee on Science and Astronautics, headed by Rep. Overton Brooks (D.-La.).

These opinions were expressed:

- **Dr. Hugh L. Dryden**, deputy administrator, National Aeronautics and Space Administration – "Our evaluations have made it clear that the space program will require the application of nuclear energy sources in order to provide large amounts of energy that are required to move about freely in space. We are confident that the future of extensive manned exploration of the moon and planets rests on the mission capabilities afforded by nuclear propulsion systems."
- **Harold B. Finger**, manager, NASA-Atomic Energy Commission space nuclear propulsion office–"I believe it [the Rover project] is essential to this country's space program and to this country's technological stature in the world. It can provide the space program with a source of propulsive energy that will propel heavy vehicles on difficult lunar and planetary missions with sufficient margin to permit maneuverability, added safety features, and, in general, increased freedom in space."
- **Brig. Gen. I. L. Branch**, Air Force assistant deputy chief of staff, development for nuclear systems–"The advanced technology program associated with Project Rover is a new development in propulsion technology. While the definition of Air Force requirements must wait upon sufficient engineering demonstration, the potential is already apparent."
- **Dr. Glenn T. Seaborg**, Atomic Energy Commission chairman–"It is my belief that nuclear energy could enhance our space exploration capability. The mission analysis data for nuclear rockets indicates significant performance advantages of nuclear systems over conventional systems for long-range or high energy space applications."
- **J. L. Atwood**, president of North American Aviation, Inc., speaking for the company's Rocketdyne Division–"It [the nuclear rocket engine] is absolutely necessary for the extension of our current capability, and the nuclear engine should be placed in development immediately as a complement to the big booster engines and hydrogen upper stages now under way."
- **W. E. Zisch**, vice president and general manager, Aerojet-General Corp.–"We recognize fully the significance and importance of this major advance in space technology . . . The nuclear rocket is, of course, most attractive for space missions of long distance, for shuttle operations between earth and moon orbits and for maneuvering in space. We believe that eventually complete control of nuclear technology will permit a nuclear rocket booster flight directly from the earth's surface and will provide the lowest cost system for large payloads."
- **John W. Simpson**, Westinghouse vice president in charge of the Atomic Power Division–"The nuclear rocket engine is the key to greater outer space capabilities. It offers efficiency, simplicity, reliability and the biggest single improvement in our rocket capability in this decade . . ."

In another hearing last week, before the Joint Congressional Committee for Atomic Energy, Krafft A. Ehricke, Centaur program director of the Convair Astronautics Division of General Dynamics Corp., also urged greater effort be put to the nuclear program.

Ehricke warned that Soviet vehicle development "appears to have proceeded faster than ours in the last two years," and that there is a definite possibility that the Soviets, by clustering their boosters, could achieve a thrust in excess of 3.5 million lb. by the time the Saturn 1.5-million-lb. thrust clustered booster becomes operational in the U.S. in 1964, thereby increasing their lead to an even greater extent.

NASA S-45 Satellite

Washington–The S-45 ionospheric beacon satellite, which failed to go into orbit Feb. 24, will be launched again within two months using a backup flight payload and backup Juno II launch vehicle.

The 74-lb. satellite, designed to sample the structure of the ionosphere at altitudes from 240-1,600 mi., did not go into orbit in its initial attempt apparently because of an upper stage malfunction. Telemetry was lost about 10 sec. after main stage separation, and doppler data was lost soon after.

There are two Juno II launch vehicles remaining in the National Aeronautics and Space Administration inventory, one scheduled to launch a gamma ray astronomical satellite.

"I do not know how much the Soviet space planners are counting on nuclear vehicle developments," Ehricke said, "but it is apparent that here, if anywhere, is an area in which our scientific strength can be brought to bear for the advancement of our strategic mission capability."

He said he felt it was important to lift the first generation nuclear engine, the Nerva engine, above the level of a state-of-the-art development program and make it a mission integrated development program, thereby installing a much needed "sense of urgency" into the nuclear engine program.

The most important practical requirements for accomplishing an effective mission integration, he said, are:

- **"The establishment of a DX-priority** schedule for the Nerva engine and associated stage development, aiming at a flight tested engine-vehicle system by the end of 1966.
- **"Start of the hardware** phase on all relevant engine components, not only the reactor, as soon as possible, still in this fiscal year.
- **"Enlarge the Los Alamos engine** test stand capacity by at least one, preferably two additional test cells in the next two years.
- **"Establish a nuclear launch** facility within the next four years. With this, I mean a facility which would be used to launch a chemical Saturn C-2 with an orbital nuclear stage.
- **"Establish the necessary safety** requirements and lay the diplomatic and educational groundwork for a national and international understanding of the low-risk manner in which we plan to break into the nuclear vehicle program."

Gen. Branch said that since the Air Force initiated Project Rover with the AEC in 1955, it still maintains close contact with the program although no longer associated with it.

The Air Force, he said, has initiated a comprehensive detailed study requirement to generate and define nuclear rocket engine characteristics over a wide thrust range. This is to provide data for direct support of a series of specific military space application study requirements which exist for advanced space systems. He said that the Air Force is interested in exploiting the nuclear rocket for military applications as an upper stage, as an in-space propulsion device, and possibly as a single stage launch system.

USAF Promises House Committee Action on Missile Base Problems

By Katherine Johnsen

Washington—Air Force has assured a House Appropriations subcommittee investigating what it terms "a terrible mess" in the missile base construction program that prompt action will be taken to clarify management responsibility and settle legitimate contractor claims against the government.

President Kennedy said at his news conference last week that the investigation, headed by Rep. Harry Sheppard (D.-Calif.), "was most helpful. I think the Department of Defense will benefit from it, and we will attempt to improve the program."

Contractor claims total over $116 million for work on Atlas D, Atlas E, Atlas F, and Titan I bases.

The 17 major missile base construction contractors protested again and again in their testimony to the subcommittee that constant and voluminous change orders by Air Force and USAF delay in decision-making had forced them into inefficient operations—from marking time to three-shift accelerations—to meet the operational dates set by USAF. They emphasized that they were placing their case before the subcommittee because the Air Force had declined to cover the additional costs for which it was responsible.

Air Force countered that "not a single contractor accepted our offer to discuss its problems." USAF Under Secretary Joseph Charyk said that in many instances the contractor claims were not justified, were due to poor contractor performance, and involved "flagrant misrepresentation of facts."

The root of the trouble was two-fold:

- **Air Force's concurrency** plan, under which base construction is proceeding concurrently with missile development and production, necessarily rules out firm and detailed specifications at the outset of construction and means continual revisions as work progresses.
- **Army Corps of Engineers,** however, let competitive bid fixed-price contracts, in which contractors neither anticipated nor could anticipate the revisions which would be required.

In its latest award—$61 million for Minuteman facilities at Malmstrom Air Force Base—Army Engineers has switched to a fixed-price incentive-fee type contract. A major segment of the construction industry is also skeptical of this type contract because it involves the advance setting of a reasonably firm target price.

The total cost of base facilities for 13 Atlas squadrons and 12 Titan squadrons will reach $991.6 million if contractor claims are paid. Two additional Titan squadrons are proposed for funding in Fiscal 1962.

The average base cost per squadron is estimated at: Atlas D, $28 million; Atlas E, $37.2 million; Atlas F, $44 million: Titan I, $50 million; and Titan II, $35 million.

The completion date on the construction of launchers and control centers for Atlas D and Atlas E missiles has been up to six months behind schedule. It is now estimated that these facilities for Atlas F, Titan I and Titan II squadrons will generally be completed on schedule.

Construction Status

Here is a status report on construction of launchers and control centers released by the House subcommittee:

- **Atlas D.** Construction has been completed at all three sites at which these missiles will be located: one squadron at Vandenberg AFB, Calif.; one at Offutt AFB, Neb., and two squadrons at Warren AFB, Wyo. The first squadron at Vandenberg has the missile in a vertical position at all times. One squadron at Warren is on the 1x6 concept with six missiles in a horizontal position in one location. The other squadron at Warren and the squadron at Offutt are on the 3x3 soft configuration.

Minuteman Base Team

Washington—First operational Minuteman ICBM base will be built by a team composed of Del E. Webb Construction Co. and George A. Fuller Co. under the first fixed-price incentive type contract awarded for ICBM base construction.

The Minuteman base will be built at Malmstrom AFB, Great Falls, Mont., under a $61,773,644 contract the Army Corps of Engineers Ballistic Missile Construction Office will award to the joint venture team. The $61,773,644 cost is an initial target price, and the final amount will be reached later within a set limit.

Original bids for the Minuteman construction job were rejected last December when they ran more than 50% over the government estimate of $50,816,500 (AW Dec. 26, p. 16). Lowest bid then was $78,907,000. Contractor was chosen last week after new bids were submitted.

Construction will start this month and is to be completed within 20 months. The project includes construction of 150 missile silos, 15 launch control centers, auxiliary buildings and miscellaneous equipment. It covers an area of about 10,000 sq. mi.

- **Atlas E.** Construction to house one squadron at Warren, one at Fairchild AFB, Wash., and one at Forbes AFB, Kans., is 97 to 100% completed. These three squadrons are on the 1x9 semi-hard concept.
- **Atlas F.** Construction is scheduled for completion between June and November of this year at the six bases at which one squadron each is to be located: Schilling AFB, Kans.; Lincoln AFB, Neb.; Altus AFB, Okla.; Dyess AFB, Tex.; Walker AFB, N. M., and Plattsburgh AFB, N. Y. These squadrons, considered the "heart" of the Atlas striking force, are in the 1x12 fully hardened configuration.
- **Titan I.** Construction for two squadrons at Lowry AFB, Colo., is scheduled for completion in four to five months. Construction at four other bases for one squadron each—Ellsworth AFB, S. D.; Beale AFB, Calif.; Mountain Home AFB, Idaho, and Larson AFB, Wash.—will be completed between December and April, 1962.
- **Titan II.** Contracts for construction at three bases—Davis-Monthan AFB, Ariz., McConnell AFB, Kans. and Little Rock AFB, Ark.—to house two squadrons each, were let last November and December. The work is scheduled for completion between January and April, 1962.

Comments by construction witnesses before the subcommittee included:

- **W. Cordes Snyder,** president, Blaw-Knox Co. "The invitation to bid called for completion of the first site within approximately 12 months . . . However, commencing almost immediately after construction began, and continuing to date, thousands of design changes, incorporated in hundreds of modifications and change requests, have been made . . . Approximately 100,000 detail changes were involved . . ."
- **Paul Hardeman,** president, Paul Hardeman, Inc. "We started out with what looked like a small $500,000 project. Imagine our surprise when we were promptly handed 9,600 drawings . . ."
- **C. H. Leavell,** president, C. H. Leavell Co. "Never before has such a combination of underground construction and delicate, precise, and ultraclean components been combined together in such a project. The propellant loading system is complex, requires surgical cleanliness . . . The tolerances for the concrete, steel, and pipe work are without precedent, manufacturing techniques are new, and workmen for them and the installation must be trained for the specific task . . ."

Defense Changes Prepared for Congress

Washington—President Kennedy has received the Defense Department's proposals for changes in U. S. military strategy and organization, and he expects to have his recommendations ready for Congress next week.

The President said last week that he has the results of Defense Secretary Robert S. McNamara's review of military strategy and that part of the recommendation is to "strengthen conventional forces." But he denied that there will be any major shift in emphasis away from nuclear capabilities.

"We have reached no decision which would indicate that there has been a change in our reliance," President Kennedy said. "If we do reach a change in our reliance in new weapons, we will make it very clear. But no such change has been reached at the present time. What we are anxious to do, of course, is to see conventional forces strengthened, not only in western Europe, but throughout the world."

The issue of bolstering conventional forces arose earlier in the week when Secretary of State Dean Rusk was reported to have advised the Defense Department that nuclear weapons should be reserved to deter or respond to nuclear threats, and that attacks on Europe and limited wars elsewhere should be handled with conventional forces unless the enemy uses nuclear weapons. Thus, the philosophy of automatic retaliation with nuclear weapons would be tempered, and the United States would maintain strong enough conventional forces to have the option of avoiding nuclear war.

Rusk immediately denied the reports, saying that present U. S. military commitments are well known and that the United States is determined to stand by them.

The need for a diversified U. S. military capability, prepared to fight either nuclear or conventional war, also was discussed last week by top Pentagon officials during House Armed Services Committee hearings.

The need for this flexible capability is clear, Army Secretary Elvis J. Stahr, Jr., told the committee, because the Soviets, while progressing with long-range nuclear weapons and defenses against them, also continue to push the modernization of their conventional land, sea and air units. In addition, Soviet military modernization is making available large numbers of effective weapons for other communist nations, including Communist China.

While not discussing specific programs required to meet the threat which have been recommended in the report to the President, Stahr told the committee that these major actions should be taken:

- "**We must maintain** the strong alliances we now have.
- "**We must maintain** a balanced and diversified military posture which will enable us both to deter any enemy from initiating a general thermonuclear war, and to confront him with powerful reason not to initiate other forms of war.
- "**In the event** of long-range nuclear attack on us, we must be able to endure, and to minimize, its effects upon our homeland, and to deliver devastating long-range nuclear counterattacks on the enemy. We must also be able to carry on successfully the prolonged conflict which might follow such exchanges.
- "**In the event** of the outbreak of other forms of war, such, for example, as occurred in Korea and Indochina, and could recur on smaller or larger scales, and in more than one place at once, we must be prepared to win—and the more quickly, the better from every standpoint. This means highly modern dual-capable forces and the ability to move and support our forces in a hurry.
- "**To achieve these ends,** our posture should include modern land, sea, and air units which can fight quickly and effectively with or without nuclear weapons and sustain the fight as long as necessary—the best possible air defense and anti-missile systems—an adequate command and control system—powerful long-range nuclear delivery systems of minimum vulnerability — and truly ready military reserve forces, together with stockpiling programs which will provide essential base both for our post-attack recovery and for assisting in the military exploitation of the strategic opportunities resulting from thermonuclear exchange."

Lt. Gen. Arthur G. Trudeau, chief of Army research and development, described development of the Counter-battery Radar. This radar will be a mobile, ground-based system which is to be capable of detecting enemy artillery shells and ballistic missiles and accurately locating their origin. Development of this system is to be completed in Fiscal 1963.

In the field of surface-to-surface missiles, Gen. Trudeau said the Army was working on Missile A for support of battle group size units and Missile B for general support of a division. Missile A will be a simple, rugged, low-cost, highly mobile system which will deliver both non-nuclear and nuclear warheads. He said it will have the mobility of a jeep and will be capable of being transported in Army aircraft. Missile B will be a self-propelled lightweight system also capable of firing both nuclear and non-nuclear warheads. Its guidance system will be simple and low in cost compared with other guided missiles, and it will be at least as mobile as a 2½-ton truck and also will be air-transportable.

However, the Army is currently conducting a component development program, Gen. Trudeau said, and the results will be evaluated against requirements before further development is continued. If it appears technologically feasible, the Army may be able to develop one missile which will meet the requirements of Missiles A and B.

Maj. Gen. John M. Willems, assistant chief of staff for intelligence, told the committee that the principal Soviet weapon for intercontinental attack now is the Russian long-range bomber. Although the number of bombers is expected to diminish in the next few years, there will continue to be a manned bomber capability which is of concern to the U. S. for the future.

Ballistic missiles of both intermediate and intercontinental range and submarine-launched missiles are assuming increasing importance, he said. The Soviets have also adopted a new system for deploying missiles. The first generation of surface-to-air missiles was deployed around Moscow in a dense and costly complex. The new systems, however, are designed for static or mobile deployment, and they have been widely dispersed. In their second post-war generation of rocket launchers, there has been a transition from truck-mounted launchers to full-tracked launchers, Gen. Willems said, another indication of the Soviet concern for mobility.

New Fighter-Bomber

Washington—New Defense Department philosophy on methods of delivery and types of weapons for conventional warfare is expected to be reflected in the decision on tri-service requirements for the Air Force STOL fighter-bomber (FTX).

Final details on the FTX project, which is being reviewed to make sure it includes requirements of all three services, were worked out between Air Force, Navy and Army at the secretary level last week for Specific Operational Requirement 183. The plan was sent to Defense Director of Research and Engineering Dr. Herbert F. York for final determination.

Industry Communications Satellite Could Be Flown With NASA's Relay

Washington—Industry-produced communications satellite could be flown concurrently with the government-sponsored Project Relay if the experimental Relay satellite performs successfully in its first launch attempt.

National Aeronautics and Space Administration Relay program is aimed at flight and ground systems development and components tests to demonstrate commercial feasibility of a low-orbiting, active communications repeater.

With supplemental Fiscal 1961 and regular Fiscal 1962 funds, NASA hopes to have two Delta and one Atlas Agena B launch vehicles for the program. One Delta is a backup, and Dr. Hugh L. Dryden told a House appropriations subcommittee that if details can be settled, and Relay I is successful, the backup Delta could be made available to industry on a reimburseable basis.

Other recent developments in satellite communications programs include:

- **Extension of frequencies** planned for the Relay satellite to include the microwave spectrum for ground to satellite communications.
- **Postponement of Project Relay** proposal deadline from Mar. 8 to Mar. 22 because of the frequency change.
- **Publication** of a NASA-Federal Communications Commission memorandum of understanding outlining areas of responsibility and coordination.
- **Receipt by FCC** of a number of company studies requested by the commission on global communications, including space communications.

Program objectives for the government's satellite communications research program were outlined for the Senate space committee by Leonard Jaffee, NASA communications satellite programs chief.

Relay project, described at a bidders' conference Jan. 24, is designed to experiment with wideband signals and ground antenna pointing and to determine orbital behavior, satellite life and effects of radiation on system components and solar cells. The 41 companies attending the briefing received telegrams last week advising them that NASA wanted to determine the effects of moving the frequencies for ground to satellite from 400-500 to 5925-6425 mc. Satellite-to-ground frequencies would change from 2200-2300 to 3700-4200 mc.

Jaffee told AVIATION WEEK that both frequency ranges are open to bidders, but the higher frequencies allow sharing with ground instruments.

The NASA-FCC memorandum of understanding underscores the need for a satellite communications system, developed through private expenditures and operated by private enterprise. NASA responsibility is the research and development phase to advance a commercial communications satellite system. FCC will develop a communications policy, will license and regulate common carriers.

The FCC said it had received global communications studies from Associated Universities, General Electric Missile and Space Vehicle Department, Hughes Aircraft Corp., National Academy of Sciences and Radio Corp. of America.

The GE study recommends a 1,000-lb. payload in a 6,000-mi. equatorial orbit. Worldwide system with 18 terminals would have 600 two-way voice channels. It would cost $280 million, compared with $475 million for an equivalent cable system, GE said.

RCA proposes synchronously orbiting satellites, two for transatlantic, and three for worldwide communications. The system could handle 1,000 two-way telephone channels, RCA said.

Jaffee said no policy decision has been made on the optimum satellite for communications, and he outlined plans to the Senate committee for NASA's continued development of a rigid passive satellite and the low-altitude active repeater, which would weigh about 100 lb. and orbit from 3,000-6,000 mi. He said NASA also is watching the Army's synchronously orbiting Advent active repeater.

The Army will award a $2.7-million contract to Space Technology Laboratories for systems engineering support and technical consultant services for Advent. Ground stations will be at Fort Dix, N. J., Camp Roberts, Calif., and on a Navy ship.

NASA's passive program includes launch of a single 135-ft. sphere, called Echo II; launch of three rigid spheres by a single Atlas Agena B in the Rebound program, and launch of six rigid spheres by one Centaur, also in the Rebound program.

Thor Agena B will launch Echo II in late 1962; Atlas Agena B Rebound program will start in late 1962 and Centaur Rebound project in 1963.

Army Tests Solid Engine With Light Titanium Case

Army Ordnance Missile Command has fired a solid-fuel rocket engine with a titanium case that is termed "the highest performance, full size, metallic propulsion unit, pound for pound," ever successfully fired in the U.S.

The titanium case used in the firing was developed by Pratt & Whitney Aircraft Division of United Aircraft Corp. and the Thiokol Chemical Corp.

Moon Mapping System to Be Developed

Pasadena—Advanced development contract for a prototype of a photographic system, which may be used for mapping the face and back side of the moon from a projected lunar orbiting vehicle, will be awarded soon by National Aeronautics and Space Administration's Jet Propulsion Laboratory.

If funds are made available for the lunar orbiter project, JPL will aim at a 1964 firing, using an Atlas-Centaur launch vehicle. This would sandwich the orbiter shot between the Surveyor lunar soft-landing spacecraft series which is scheduled to begin in 1963 and extend through 1966.

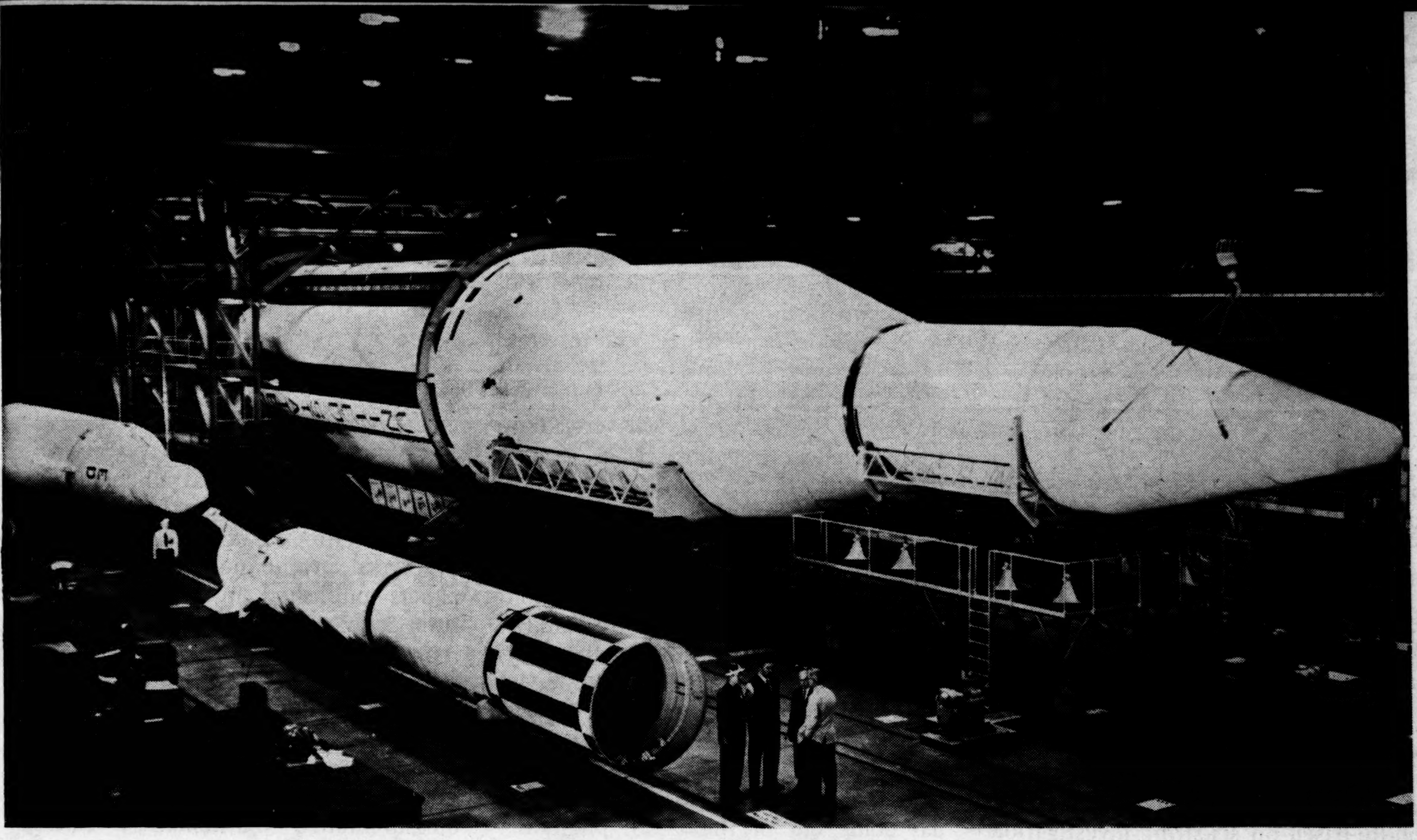
Three studies of the mapping system, known as visual observation instrumentation subsystem, or Vois (AW Oct. 17 p. 27), were recently completed for JPL and are now being evaluated. The anticipated JPL contract will cover construction of a prototype of one of the three suggested systems.

Exact award date is not yet set, but JPL is anxious to make the contract final before the winning Vois study team has been disbanded. The studies were conducted by Eastman Kodak, Fairchild Camera & Instrument and Radio Corp. of America's Astro Electronics Division. The three approaches reportedly differ primarily in the choice of imaging techniques for the mapping system.

The Vois studies constitute the only subsystem of the proposed orbiter which has been handled outside JPL. Because of the relatively large size of the optics and the photo mapping system, this subsystem is expected to determine the limits of the lunar orbiter. The subsystem also requires longer leadtime than other portions of the vehicle.

The Vois system is expected to be capable of mapping the moon to a resolution of 100 meters and perhaps to one meter for selected objects.

Lunar orbiter may also carry infrared equipment for thermal mapping of the moon. Gama ray experiments and detailed measurements of solar plasma also may be conducted from the lunar orbiter. All data will be transmitted back to earth stations for processing.



NASA Three-Stage Saturn Rocket Assembled

Flight configuration of three-stage Saturn C-1 rocket is shown at the National Aeronautics and Space Administration's George C. Marshall Space Flight Center, Huntsville, Ala. Dwarfed by the 180-ft. Saturn are a Juno II (left, rear) and a Mercury-Redstone booster in the foreground. A modified Centaur built by Convair Division of General Dynamics Corp. is the Saturn third stage. The first stage, developing 1.5 million lb. of thrust in its eight engines, is built by the Rocketdyne Division. Second stage is built by Douglas Aircraft.

Major Reorganization Of Convair Expected

Major reorganization of the Convair Division of General Dynamics Corp. is expected to follow the resignation of J. V. Naish as president last week.

C. Rhoades MacBride, executive vice president of General Dynamics, will assume direction of Convair as acting president for a three- to four-month period during which the pattern for reshuffling Convair operations within the corporate framework is expected to crystallize.

Major issue in Naish's resignation was the heavy loss incurred on the Convair 880-990 jet transport program. Frank Pace, General Dynamics board chairman, recently wrote a letter to stockholders (AW Feb. 20, p. 30) announcing that the earlier $96.5-million pre-tax write-off labeled as covering all the anticipated jet transport development costs actually would not be sufficient and further losses could be expected from the program.

Airlines which have purchased the 990 indicated that initial flight tests showed the aircraft's performance fell considerably short of performance guarantees and substantial modification will be required to enable it to meet its short field takeoff and landing specifications. There also is industry speculation that the Whitcomb area rule drag reduction protrusions on the trailing edge of the wing have caused stability problems not found in the earlier 880 series.

Naish said his decision to resign was based on "amicable but irreconcilable differences in management philosophy." MacBride was billed in a General Dynamics press release as having "been associated with the aircraft industry for 20 years." However, he joined General Dynamics in 1958 as vice president-operations and a member of the board of management.

Prior to this, MacBride was a partner in Robert Heller & Associates, a management consultant firm, beginning in 1943.

The Heller firm was hired by General Dynamics to make management studies resulting in the present Convair management structure, and MacBride was active in this operation, from which he joined General Dynamics. He served in the Navy for 19 months during World War II, and prior to that had been a district market development manager for Westinghouse Electric Corp., manager of the A. M. Byers Co. engineering service department in Pittsburgh and an assistant superintendent of rolling mills of the Edgewater Steel Co., Verona, Pa.

Major trends that will probably characterize the impending reorganization will include absorption of some Convair Division electronic operations in the newly created General Dynamics Electronics Division, consolidation of some aircraft and missile manufacturing facilities, a reduction in general office overhead and centralization of some management functions at the General Dynamics corporate level.

Aerospace Earnings Rise

Martin Co., Baltimore, Md., reported 1960 earnings of $16,854,540, up 26.4% from 1959 earnings of $13,336,981.

The 1960 earnings amount to $5.34 per common share, up from $4.34 declared in 1959. Sales of $651,227,929 increased 24.3% from $523,707,022 in 1959.

Simultaneously, North American Aviation Corp. Chairman J. H. Kindelberger stated that the company's backlog, with funds actually committed, is about $892 million, compared with $659 million a year ago and that sales of more than one billion dollars and earnings better than the $2.87 a share of a year ago were predictable.

Thompson Ramo Wooldridge reported a net income of $10,176,155 for 1960, equivalent to $3.13 per share of common stock, compared with $9,743,918 or $3.02 per share reported for 1959. Sales during 1960 amounted to $420,421,158, a slight gain over 1959 sales of $417,748,953.

NASA Says U.S. Space Sciences Outstrip Soviet Union's Efforts

Washington—U. S. space sciences program has gathered momentum after a standing start and has now outstripped the Soviet Union's effort, according to a National Aeronautics and Space Administration evaluation prepared for the House space committee.

The Soviet space science program had lost ground to the U. S. as of mid-January, according to NASA, because of these basic differences in the way the two countries approach their programs:

- **Policy planning:** Soviet scientists are unable to participate in forming projects, while the scientific influence is strong in this country.
- **Prestige:** Soviet planners are preoccupied with prestige and the world image of Russian scientific and technical achievement. The U. S. program is solidly based on scientific investigation.
- **Personnel:** Although equal to the U. S. in talent and ability, the Soviet research capability is new and relatively thin. The U. S. has a larger scientific base developed over several decades.
- **Instrumentation:** Soviet Union has failed to follow promising experiments with advanced scientific apparatus. The U. S. is developing second generation instruments and spacecraft.

The NASA study, released last week, was submitted to the House space committee Jan. 16, before the last two Russian Sputniks were launched.

It cautions that the comparative situation described was a reflection "as of that moment," and adds, "we should anticipate that the Russians will respond to this [U. S.] challenge with a more vigorous space science program of their own in the future."

The report was written in response to a committee request for a current comparison of information being released by U. S. and USSR based on space science programs. It is a compilation of conversations, reactions at international scientific meetings and tracking and data analysis.

NASA believes that the scientific talent in the two countries is about equal, and the range of scientific ability about the same. Although Russia is training about twice the number of scientists as the U. S., and the Soviets possess an acknowledged lead in payload weight capability, "nearly all the highly original work in space research has come out of the U. S. program."

This conclusion is based on the small number of USSR flights, some reflecting "great achievements in space technology" but relatively little in basic scientific investigations. First two Soviet satellites, according to the study, "had little or no scientific apparatus."

Sputnik III geophysical satellite was heavily instrumented, and "it is very difficult . . . to understand why the USSR failed to follow up the remarkable flight of Sputnik III with further geophysical satellite experiments," NASA said.

The USSR chose its missions "with close attention to their impact on world opinion and their effectiveness in reinforcing the public image of USSR strength in science and technology," the report said.

Contrasted with the paucity of Soviet findings, the report credits the U. S. with major achievements such as detection of the Van Allen radiation belts; detailed investigation of trapped radiation; interplanetary communication and study of interplanetary properties with Pioneer V; satellite drag measurements with the Echo satellite; ionospheric measurements during solar storms; Tiros cloud cover photographs; Echo passive communications tests and contributions to geodesy and celestial mechanics.

Comparison between the findings of the two nations is reflected in a sizable difference in the number of scientific papers published in periodical literature or presented at conferences, the report says. Evaluation of recent scientific literature has resulted in these impressions in the NASA report:

- **Quality:** U. S. and USSR papers cover about the same range. Russia is strong in cosmic radiation, energetic particle measurements, mathematics, celestial mechanics, astrophysics, seismology and oceanographic observations. Soviets are weak in publication of geodetic applications, possibly because it is considered a sensitive area.
- **Quantity:** U. S. presented 40 papers to 10 by the Soviets at the 1960 Cospar meeting. Each nation had five articles published in 1958 issues of the Journal of Geophysical Research. The U. S. had 64 authors the following year, and Russia eight. In 1960, U. S. had an estimated 111, and Russia, 17.
- **Publication details:** Soviets give no orbital or tracking data, and are secretive about launch vehicles. Early sketchy details on experiments apparently have been relaxed, as shown in a recent Soviet proposal for an international conference on lunar research, to be held in Leningrad in December.
- **Timeliness:** Preliminary Soviet technical notes appear 6-8 weeks after launch, about the same as in the U. S. Detailed reports are made about 12 months after launch, as compared with six months in the U. S.
- **Channels:** Early Soviet launches were reported in Pravda, but subsequently have been published in what was called "normal channels of scientific communication and away from the public press."

A comparison of U. S. and USSR space efforts was made in 1959 by Dr. Homer E. Newell, Jr., deputy director of NASA's Space Flight Programs (AW Dec. 21, 1959, p. 36). It differed in its approach in that it compared in detail all major programs of the two countries, while the more recent study assesses the extent of the Soviet program based on scientific literature.

Optical Space Communications Study

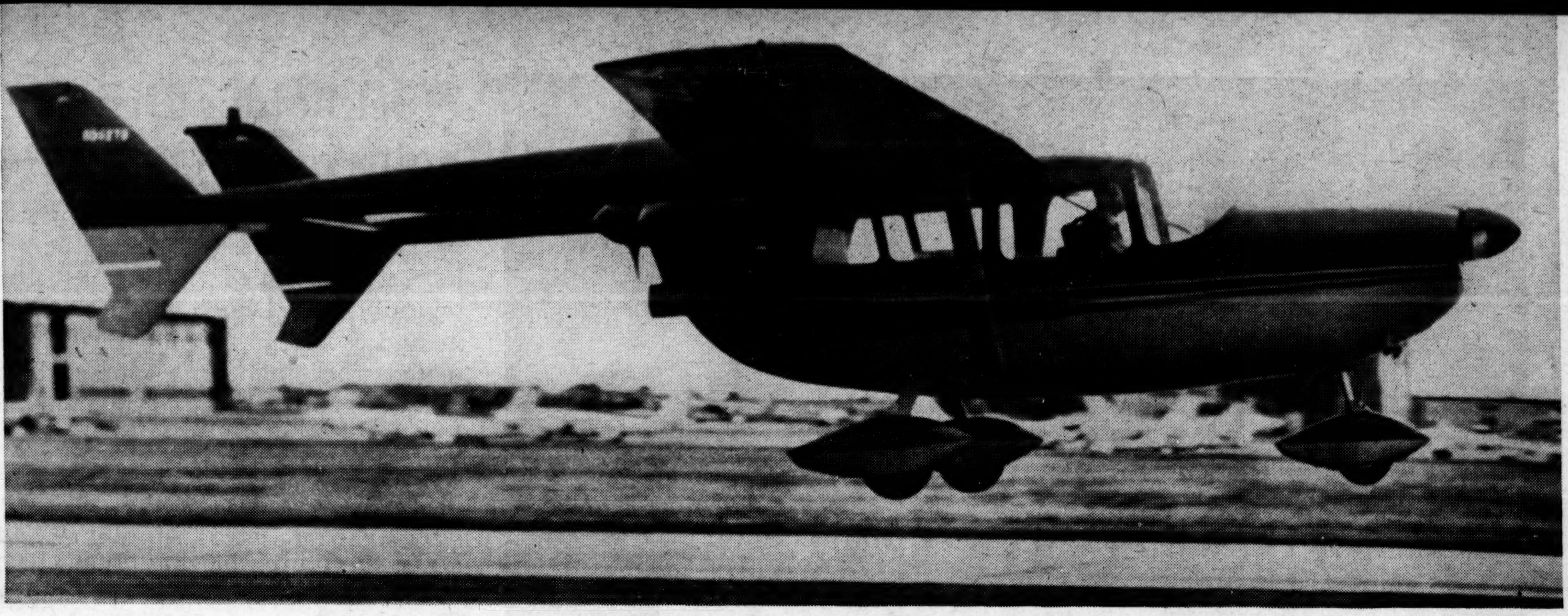
Requirements for a 14-month optical communications study contract to explore one of the most serious problems associated with this promising area of space communications will be outlined in a bidders' briefing (Mar. 8) by the Air Force's Wright Air Development Division in Dayton, Ohio. A research and development contract for the study is expected to be awarded in late May.

The problem is that of acquiring and then tracking the transmitters and/or receivers in a space communications link employing narrow beams of light rather than radio waves as the basic information carrier. Because light is radiated in very narrow beams several orders of magnitude more narrow than microwave signals, locating the radiating source and aligning the receiver on a continuous line-of-sight with it poses a serious system design challenge.

Active optical space systems which are experiencing a renewed interest as a result of current development work with optical masers offer a number of important advantages in space. These include security, invulnerability to jamming, possible light weight, low power requirement and/or long transmission ranges.

Potential contractors will be asked to study the limiting transmitter and receiver beamwidths as far as acquisition and tracking are concerned in two hypothetical optical space communications links. A contractor would have to determine whether tracking motions or other techniques of maintaining continuous communications with earth satellites would disturb the satellite or space vehicle. Techniques generated by the study will be evaluated under simulated conditions.

Proposals for the contract are due at WADD on Mar. 29.



First Photo of Twin-Boom Cessna Skymaster

Cessna Skymaster, four-place business plane, lifts off the ground at McConnell AFB, Wichita, Kan., for the first time Feb. 28, displaying its fore-and-aft continental twin-engine configuration aimed at providing optimum flight characteristics in the event of a powerplant failure. Swept tail surfaces are set on tapering twin booms extending from the wings. Configuration bears out Aviation Week artist's conception of the new airplane (AW Dec. 12, p. 134). Placement of the wing provides excellent visibility for a high-wing plane.

Joint Franco-British Endeavor Proposed for European Satellite

London—Hawker Siddeley Group and French Sereb consortium have initiated detailed studies into design and construction of a civil communications and navigational satellite in an effort to obtain Franco-British government contracts.

System probably will come up for comment at a meeting of the European Space Research Organization, a 10-nation group now considering establishment of a joint space effort (AW Feb. 6, p. 35). Meeting is set for Mar. 13-14 in Paris and major topics planned are study of budgets and future space programs.

Sources expect that Pierre Auger, president of the French Committee for Space Research, will be named secretary-general of the organization.

Sereb is a French company set up by the government to act as systems manager for ballistic missile development, and is a consortium of Nord Aviation, Sud Aviation and Snecma. Both Sereb and Hawker Siddeley emphasize that their satellite studies are company-funded.

The joint study envisions a four-year development program which will cost $400 million. On the basis of a British-French program, the United Kingdom would pay $59 million annually, and the French $41 million annually. Study does not designate a launching vehicle, but British Blue Streak first stage and French Veronique second stage vehicle have been mentioned in previous meetings of the space organization.

Sharing of responsibilities would be allocated on a pro rata basis according to the financial contribution of each government. Both companies stressed that any further development of the aerospace program depended on government financial support. It was also thought essential that national research establishments such as the Royal Aircraft Establishment and Onera should be combined.

Two communication satellite systems are proposed. Both employ active satellites in elliptical orbits. In the first system, satellites weighing 530 lb. would be placed in orbit containing a stabilization unit for station-keeping. A lighter and simpler alternative system would employ smaller satellites weighing between 60 and 135 lb., orbiting in a random pattern without mechanical stabilization.

For the larger satellite system the report quotes these characteristics: carrier frequency (outward) 6,000 mc., return 2,000 mc.; bandwidth 2.6 mc. (four bands), and a non-modulating repeater suitable for FM signals. The satellite would have an output of four watts and would provide 100 two-way telephone channels with a signal-to-noise ratio or 40 db.

Satellite would be placed in a 63-deg. north-inclined elliptical orbit with an apogee of 10,000 mi. and would make four orbits a day.

Power-supply would consist of a fixed array of solar cells around the instrument canister. Stabilization, in pitch and yaw only, with respect to the horizon would be effected by infrared photocells, with attitude control being effected by propane-fed reaction jets. A 4,000-psi. nitrogen source would pressurize the propane system and also would provide thrust at separation.

Alternative communication satellite systems are based on an omnidirectional satellite weighing between 65 and 135 lb., placed in orbits with different apogees varying from 2,500 mi. to 9,000 mi.

Ground equipment for each station would include two non-scanning receiver dishes aligned with accurate prediction by computers of 5,000-word capacity.

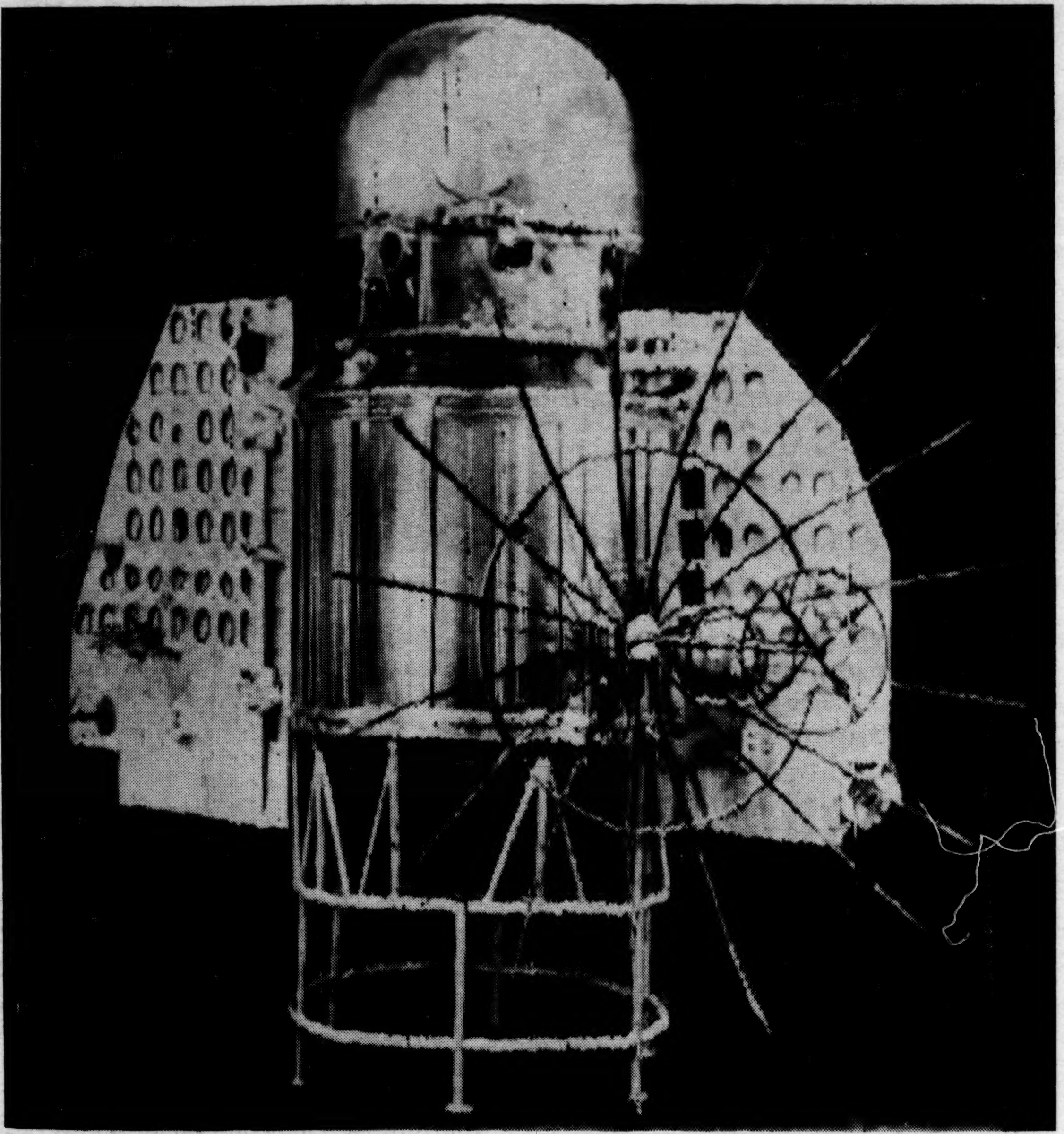
The companies said four satellites could provide 24-hr. service between any two points of latitude greater than 45 deg. north.

Basic assumption in the studies of a navigational satellite system is the ability to sight at least one satellite 10 times a day with a viewing period of between 100 and 1,000 sec.

Two proposed versions differ only in method of transmitting the astronautical data and both are based on Newtonian mechanics. Navigation system in each is based on use of atomic clocks in the satellite and on the ground, rather than on the doppler effect, as the equipment is lighter and more compact. In these systems, a quartz clock is used to modulate the signals from the transmitter.

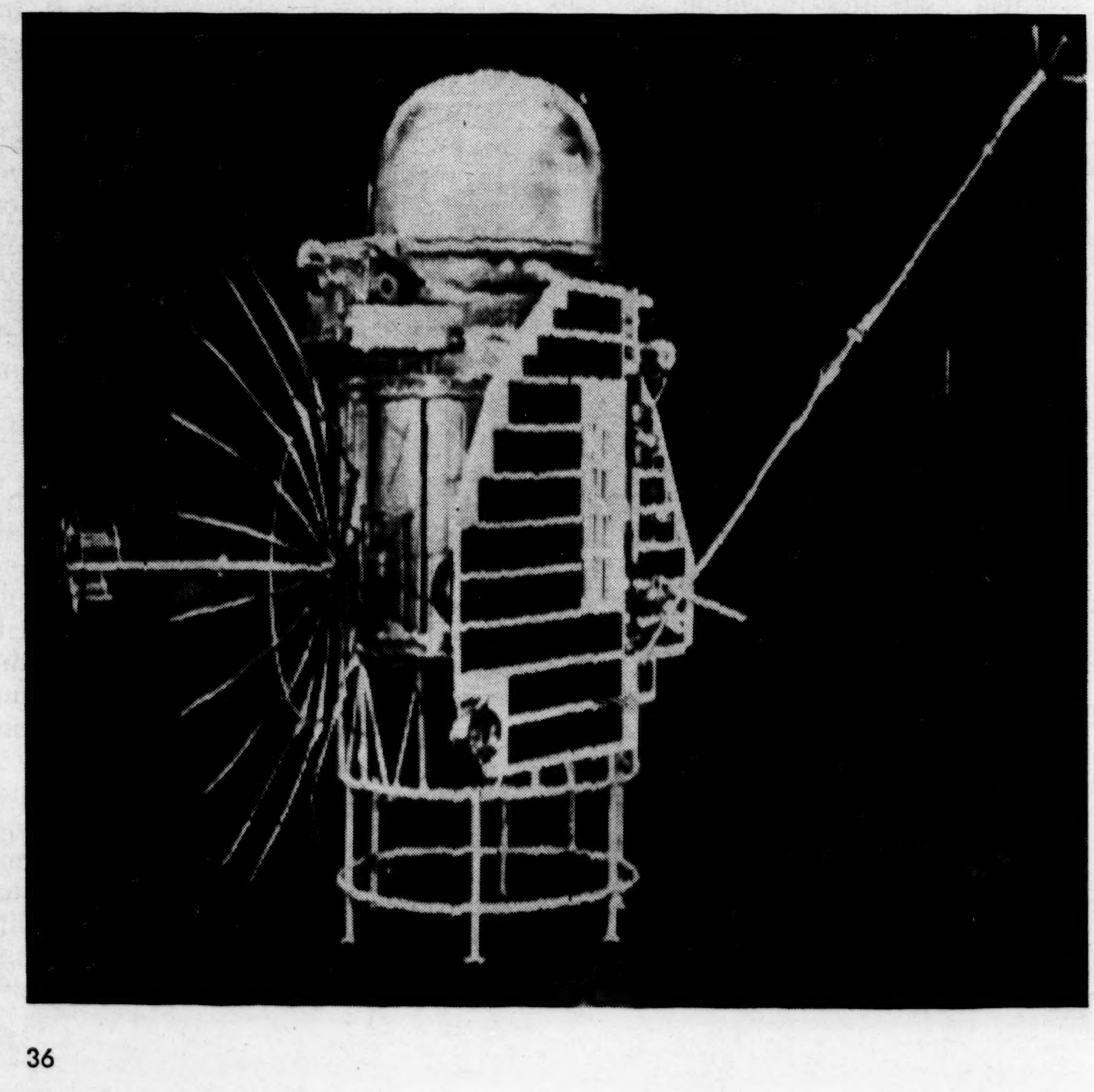
Clock frequency is quoted as between 5 and 10 mc. and the transmission frequency between 200 and 1,000 mc. Reduction circuits supply the transmitter's modulation signals from the clock pulses. Weight of the capsule, would not exceed 45 lb. and the spherical capsule diameter would be of the order of 10 in.

High and low circular orbit categories were considered with apogees between 300 and 600 mi. and the systems envisage between four and six satellites symmetrically placed in inclined orbits in pairs relative to the equator, circuiting 15 times a day.



Soviet Venus Probe Uses Solar Cell Paddles

Antenna arrays and solar cell panels are the only equipment visible in these Soviet photographs of the Venus probe. The 1,418-lb. probe, launched from a seven-ton satellite Feb. 12, is expected to make its closest approach to Venus May 20. Pictures were made public in Moscow two weeks after the probe was launched.



Stockholder Brings Suit Against Ling

Dallas, Tex.—James J. Ling, president of Ling-Temco Electronics, Inc., late last week denied allegations by a minority Ling-Temco stockholder that he and certain other individuals manipulated stock to their advantage during a 1956 organizational change in Ling Electronics, Inc.

A suit was filed here early last week by Ling-Temco Electronics, Inc., stockholder R. C. Slagle, Sr., in the 14th District Court alleging that several officers and directors of the company in 1956 obtained 235,000 shares in Ling Electronics, Inc., at a price of $1 or less and subsequently offered them to other shareholders at $3 and to the public at $3 or more.

The suit charges that these shares and the proceeds from them may have been used subsequently for Ling's merger with Temco and also to purchase shares in Chance Vought Corp.

Slagle claims that the shares named in his suit now have a value of some $7,050,000, and asks that the court impose a "constructive trust" on them or the proceeds from them, rescind what he terms an "unlawful transaction" and require that the defendants return to Ling-Temco Electronics the shares of stock or hold them liable for the present market value.

Slagle's petition states that the transaction traces back to the period in 1956 when Ling Electric, Inc., acquired all outstanding shares of L. M. Electronics, Inc., and organized itself as Ling Electronics, Inc. The petition notes that the board of directors of the new company prepared stock for public issue and "decided to adopt the strategem of advancing personal funds to Ling Electric, Inc., to be reloaned by it . . . to Ling Electronics, Inc., which loans could be used subsequently as a guise and excuse for issuing to them, personally, shares of Ling Electronics at a much lower price than the price paid by the public, in cancellation of such indebtedness."

The suit alleges that Ling Electronics subsequently issued 540,000 shares of stock to its parent company, Ling Electric and that a statement was filed with the Securities and Exchange Commission reporting that the amount of consideration was cancellation of indebtedness. A similar statement was filed in California.

At about this time, the suit alleges, 235,000 shares of the block of 540,000 shares of Ling Electronics were transferred to the individual defendants.

James J. Ling categorically denied Slagle's allegations and stated that the Ling transactions were "a matter of public record."

Nuclear Power Outlook Described For Missile, Space, Ocean Use

Washington—Industry representatives presented an optimistic outlook for use of nuclear propulsion for missiles and nuclear auxiliary power for outer space and deep ocean exploration at the annual program status hearings of the Joint Congressional Atomic Energy Committee:

- **W. P. Thayer,** vice president of Chance Vought Corp., predicted that the third military application of nuclear energy—after warheads and submarine propulsion—will be the nuclear ramjet-powered missile system.
- **Dr. Chauncey Starr,** president of Atomics International Division and vice president of North American Aviation, emphasized that compact Space Nuclear Auxiliary Power (Snap) units offer "complete safety" and "simplified control" for space operations. The three units under development are Snap 10A, a 500-watt unit; Snap 2, a 3,000-watt unit; and Snap 8, in the 30,000-60,000-watt range. Snap 4 for ocean or terrestrial uses is in the 1-3 million-watt range.

Starr Comments

"I would like to emphasize . . . the Snap reactors are radioactively 'cold' during their assembly, pre-flight checkout, launch, and early flight," he told the committee. "It is not until the reactors are determined to be in a safe orbit that reactor operation will be started." In a safe orbit, the reactor will be started and remain in space long enough after it has ceased operating—about 300 years—for its radioactive products to decay.

For lower orbital use, where return may occur before the time decay, he said, the systems are designed for complete disintegration and dispersal in the upper atmosphere by means of re-entry burn-up.

Initial flight testing of Snap 10A and Snap 2 is now being planned jointly by Atomic Energy Commission and Air Force under Program Snapshot. Snap 10A is expected to be ready for flight test in 1963, and Snap 2 in 1964.

Starr projected the development of Snap units for deep space exploration with 10 to 100 times the power of Snap 8. He estimated that a Snap unit of 300 kilowatts could be ready for final test in 1968, and a Snap unit of 3,000 kilowatts two years later. He noted that the ratio of weight to power output of Snap units will be substantially lower in the projected larger Snap units. For example, the 3,000-kilowatt unit would weigh an estimated 10 lb. per kilowatt of power. This would compare with 50 lb. per kilowatt in the 30-kilowatt Snap 8 unit.

Canadian Helicopters

Hiller 12E four-place helicopter is the leading contender for selection as utility helicopter for Canadian armed forces. Order would call for delivery of 24 aircraft, and selection will be made within a month. Competition, under way for more than a year, also involves Bell Helicopter and Cessna Aircraft. In the heavier, turbine-powered class, Kaman Aircraft is favored for sale of 12 HU2K models, probably for anti-submarine warfare use, and Vertol's 107 is leading for selection as a transport helicopter. Sikorsky Aircraft has submitted proposals for its S-61 and S-62 models.

Army Vertol HC-1B Production Ordered

Washington—Army has ordered the Vertol HC-1B Chinook turbine-powered helicopter into quantity production with an initial $25,357,544 contract for 18 aircraft.

Boeing Vertol Division's HC-1B is powered by two 2,200 shp. Lycoming T55-L-5 turbine engines driving two three-bladed rotors. Gross weight is 33,000 lb. and useful load capacity is 16,682 lb. The helicopter is designed to carry 33 combat-equipped soldiers in its 30-ft. cabin. Cruising speed is 130 kt. and combat radius with reserves is 110 naut. mi. Delivery is to begin in March, 1962.

Army already had five YHC-1B and five HC-1B helicopters ordered, and the first is off the production line and expected to fly next month. The HC-1B is a tandem rotor design, as is the smaller vertol 107-II ordered by the Marines in an assault helicopter version.

The Vertol 107-II also has been ordered by Kawasaki Aircraft Co., Boeing-Vertol's choice to build its helicopters under license in Japan. The first two of 10 Model 107-IIs will be built by Vertol, and the rest will be assembled in Japan with Vertol parts. Fuji Air Transport and Fuji Airlines will operate the helicopters.

The Model 107-II is a twin-turbine helicopter powered by two General Electric T58 engines. It has a gross weight of 18,450 lb. and is an outgrowth of the company-financed prototype Model 107 and the YHC-1A, three of which were delivered to the Army (see p. 52).

News Digest

Prof. Henry A. Kissinger of Harvard University, defense planner and advocate of stronger conventional forces, has been named a part-time consultant to President Kennedy on national security.

Dr. Leland J. Haworth, director of Brookhaven National Laboratory, has been appointed a member of the Atomic Energy Commission, bringing the AEC to full five-man membership for the first time since June 30, 1960.

Dr. Herbert F. York, defense director of research and engineering, will resign to become chancellor of the University of California's planned San Diego campus, probably next summer.

Thomas F. McGarry will become public relations director of the Air Transport Assn. Mar. 20. McGarry currently is aviation promotion supervisor, writer and editor for the Port of New York Authority.

Thompson Trophy was awarded last week to the Strategic Air Command B-58 crew that set a new world record of 1,284 mph. for a 1,000-mi. closed course (AW Jan. 23, p. 39). The Thompson Trophy performance was one of six world records set by the Convair B-58 and marks the first time this award has been won with a bomber. Trophy-winning crew consisted of Maj. Harold Confer, pilot; Maj. Richard Weir, navigator and Capt. Howard Bialas, defensive systems operator.

Heinkel of Germany and France's Air Potez Fouga have signed an agreement to cooperate on the manufacture of a new four-seat, twin-jet liaison and training aircraft to be called the Potez Heinkel CM 191.

Maj. Gen. Harold W. Grant will command the new Air Force communications service when it is activated July 1 at Scott AFB, Ill. to unify management of USAF communications.

Douglas Aircraft Co. and National Engineering Science Co. have an agreement under which Nesco is to provide research support for Douglas programs and Douglas is to supply engineering and production facilities for Nesco research and development programs.

Chance Vought Corp.'s Aeronautics Division will conduct landing gear studies covering aircraft and space vehicles under Air Force-Navy contracts.

FIRST TURBOPROP aircraft acquired by the Federal Aviation Agency—a Lockheed Electra—will be used as an airborne classroom for proficiency training of FAA pilots and inspectors and to establish capability standards and perfect techniques for pilots and flight engineers flying Electras for seven U. S. domestic airlines.

First Modified Electras Go Into Service

Eastern will take monthly delivery of balance of its 39-aircraft fleet of Super Electras through July.

By David A. Anderton

New York—First of Eastern Air Lines' Super Electras—extensively modified and rebuilt Lockheed Electra turboprop transports—entered service Feb. 24 on an extra-section "inaugural" flight from New York to Miami via Tallahassee, Fla.

Plane was one of two Super Electras now in EAL's inventory; remainder of the complete fleet of 39 aircraft is scheduled for delivery in monthly installments ending the later part of July this year. Cruise speeds of the Super Electras will be held at the restricted level of the unmodified airplanes until all are in service. Then EAL will revise its schedules to take advantage of the permitted increase in cruise speed. Other operators of the Lockheed transport plan parallel usage of the mixed fleet, and will make schedule changes only after all modified planes are in service.

Return of the modified Electras to service terminates one phase of the Lockheed Electra Action Program (LEAP), an investigation and test program which is probably the most rigorous since the exhaustive project of determining the causes of the British de Havilland Comet accidents.

The LEAP effort required hundreds of engineers, thousands of tests, hundreds of thousands of man-hours and approximately $25 million. Out of it has come a reborn Electra, strengthened and modified in wings and nacelles, and certificated to operate at its original design cruise speeds approximating 400 mph.

These modifications came about because of two related accidents to Electras: Braniff Airways' Flight 542 which crashed near Buffalo, Tex., Sept. 29, 1959, and a Northwest Airlines' Electra which crashed near Tell City, Ind., Mar. 17, 1960. Both these airplanes broke up in flight.

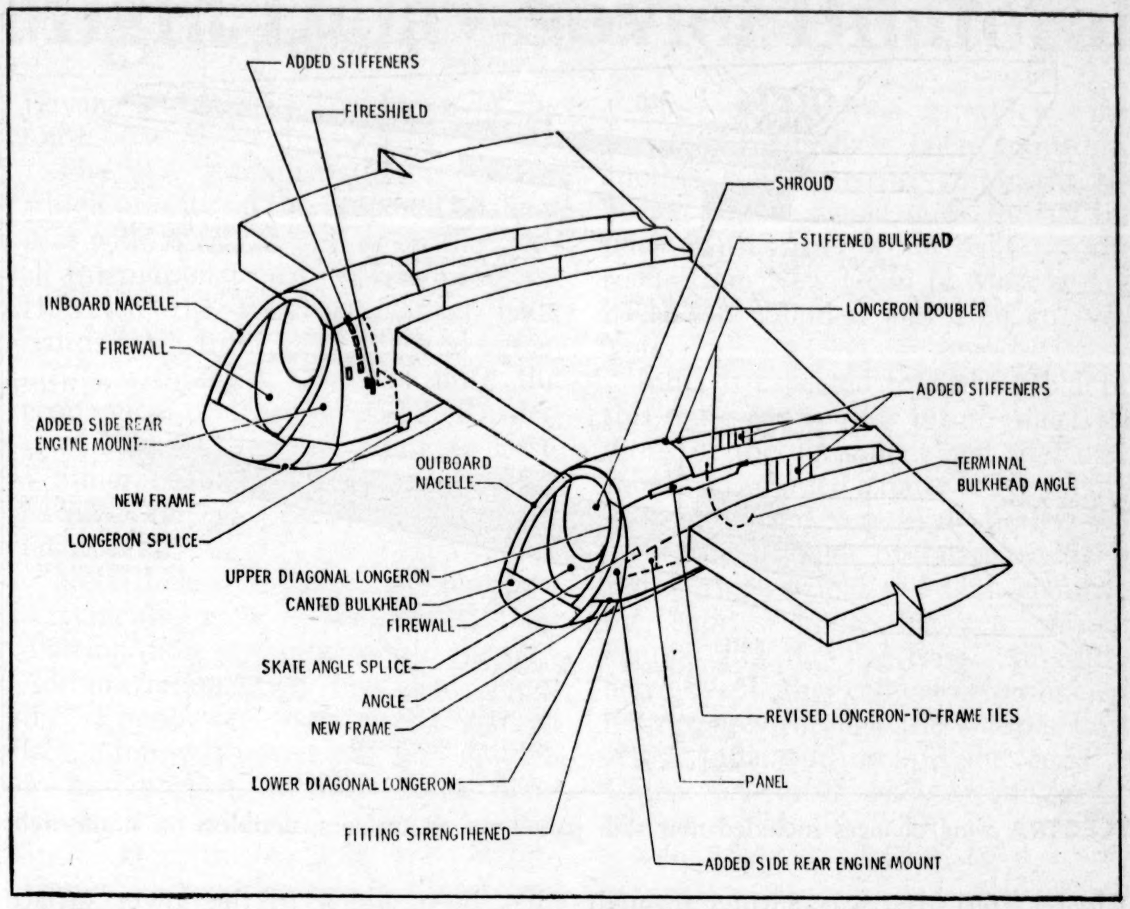
The long investigation program that followed narrowed the possible causes of the accidents down to one: "Heretofore unsuspected propeller gyroscopic forces operating in a damaged powerplant installation and in the presence of suitable excitation coupled with wing bending frequencies to overload the wing to the point of failure."

This paragraph of official engineering jargon translates to say that the wing broke while flapping wildly in resonance with a damaged powerplant installation. The flapping was started by some outside force; clear-air turbulence had been suggested earlier but was not positively blamed.

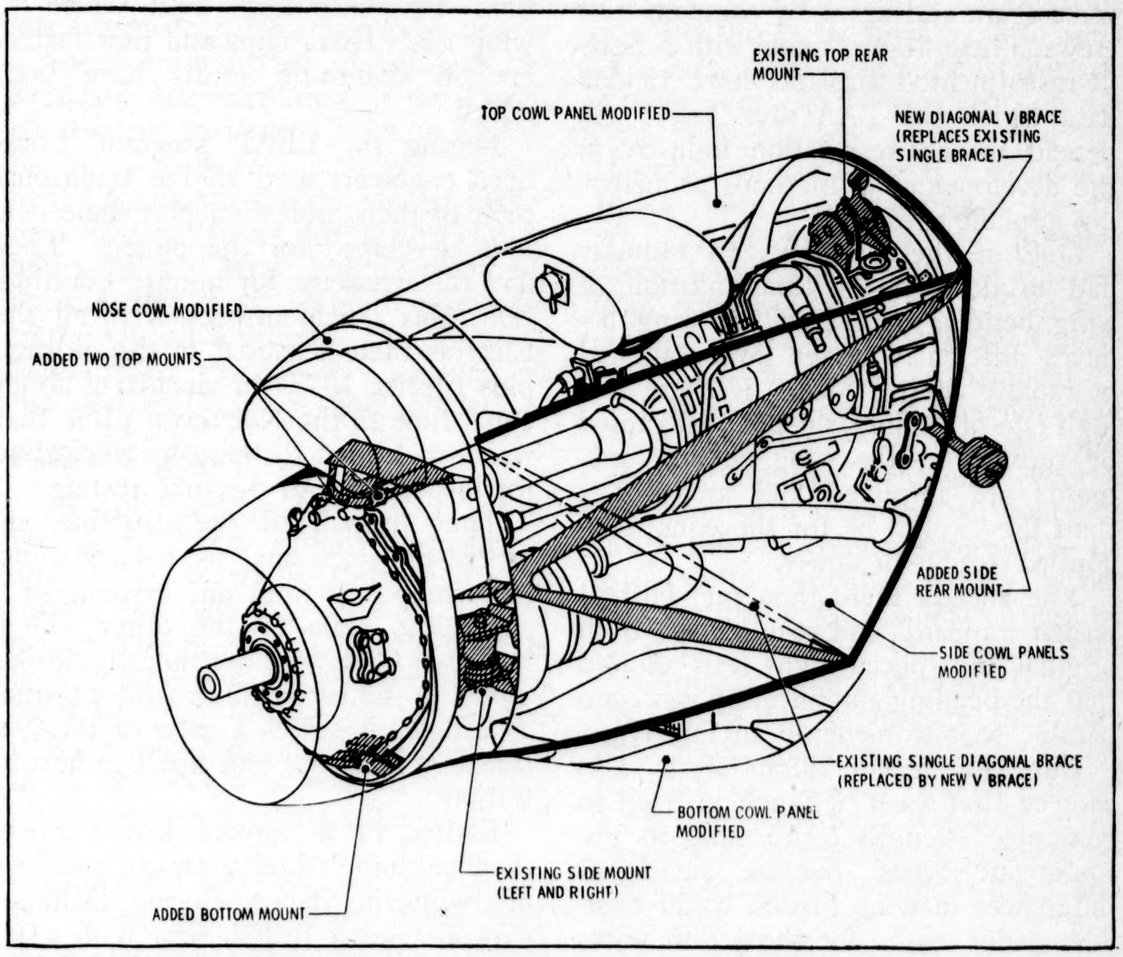
In the two related Electra accidents, there was catastrophic structural failure of the wings under violent combined bending and torsional loads. In a matter of seconds, the left wing ripped off the Braniff airplane after a wildly diverging oscillation that broke the wing in upward bending and nose-up torsion. The right wing failed on a downward beat, tearing off due to nose-down torsion and drag loads.

These loads were forced by coupled oscillations of the wing and the powerplant installation at a frequency of approximately 3 cps. Driving force for these oscillations was a damaged outboard powerplant installation, operating in the "whirl mode" at about half its normal frequency, close enough to the natural frequencies of the wing in both bending and torsion to force it to failure.

The "whirl mode" is one of several dynamic actions of the powerplant. An ideal engine-propeller combination maintains a fixed axis in space about which the propeller moves in pure rotation. But no real installation is ideal. The axis of the powerplant whirls like a flexible twig rolled between your fingers. The whirl can be in either direction of rotation, compared with the propeller, and it can be anything between a damped, stable operation, and an undamped, unstable motion. Which


ADDED STIFFENERS
FIRESHIELD
SHROUD
STIFFENED BULKHEAD
INBOARD NACELLE
LONGERON DOUBLER
FIREWALL
ADDED STIFFENERS
ADDED SIDE REAR ENGINE MOUNT
OUTBOARD NACELLE
TERMINAL BULKHEAD ANGLE
NEW FRAME
LONGERON SPLICE
UPPER DIAGONAL LONGERON
CANTED BULKHEAD
FIREWALL
SKATE ANGLE SPLICE
ANGLE
NEW FRAME
REVISED LONGERON-TO-FRAME TIES
LOWER DIAGONAL LONGERON
PANEL
FITTING STRENGTHENED
ADDED SIDE REAR ENGINE MOUNT

ELECTRA nacelle changes are detailed in this drawing showing structural modifications.


EXISTING TOP REAR MOUNT
TOP COWL PANEL MODIFIED
NEW DIAGONAL V BRACE (REPLACES EXISTING SINGLE BRACE)
NOSE COWL MODIFIED
ADDED TWO TOP MOUNTS
ADDED SIDE REAR MOUNT
SIDE COWL PANELS MODIFIED
EXISTING SINGLE DIAGONAL BRACE (REPLACED BY NEW V BRACE)
BOTTOM COWL PANEL MODIFIED
EXISTING SIDE MOUNT (LEFT AND RIGHT)
ADDED BOTTOM MOUNT

QUICK-ENGINE-CHANGE package modifications strengthened all four installations.

type of operation it will have depends on many factors: inertia of the system, elastic and damping characteristics, aerodynamic loads on the propeller and gyroscopic moments of propeller rotation. These are functions of the structure type, and its stiffness; of engine and propeller operating speeds; of the natural frequencies of individual components and the entire installation; of turbulence, hard landings, abrupt maneuvers, throttle-jockeying.

The reason a propeller-engine combination whirls is because the propeller acts like a gyroscope. If it is forced to move in the pitch plane, it reacts in the yaw plane. This out-of-phase reaction is easily felt by holding and moving a toy gyroscope.

Now suppose that the propeller is whirling smoothly, and that suddenly a gust strikes it and moves it in a pitching sense. The disk reacts by moving in yaw. If the system is stable, that's about the end of it. But if the system is not damped, or if any energy is added during that yaw motion in the direction of yaw, then the propeller disk moves again, in a pitching sense now opposite to the original direction. This can be visualized as a repeated cycle, with the reaction of the disk being aided each time by the addition of a little energy until the motion is established and the propeller-engine combination is wildly whirling.

The whirl mode is not a new phenomenon. It was originally described and briefly investigated in 1938. But it had never posed a problem in actual airplane installations. Nor was there any way to pinpoint the possibility of its occurrence in a dangerous form. Standard structural investigation techniques, either theoretical or practical, could not reveal a possible source for trouble. Lockheed's engineers, who have earned the respect of their contemporaries for their approaches to structural design, carried their analyses of the Electra wing design out to realms where the airplane would never operate, to determine if something strange might occur. It didn't.

But it did—when the structure was damaged—in a way that can't be taken into account in analysis. The damage changed the stiffness of the nacelle, and that changed its natural frequency so that it was almost that of the wing. The system was set up for divergent oscillations. The only factor lacking was an initial burst of energy to start the motion. The Braniff Electra and the Northwest Electra found that energy in their flight.

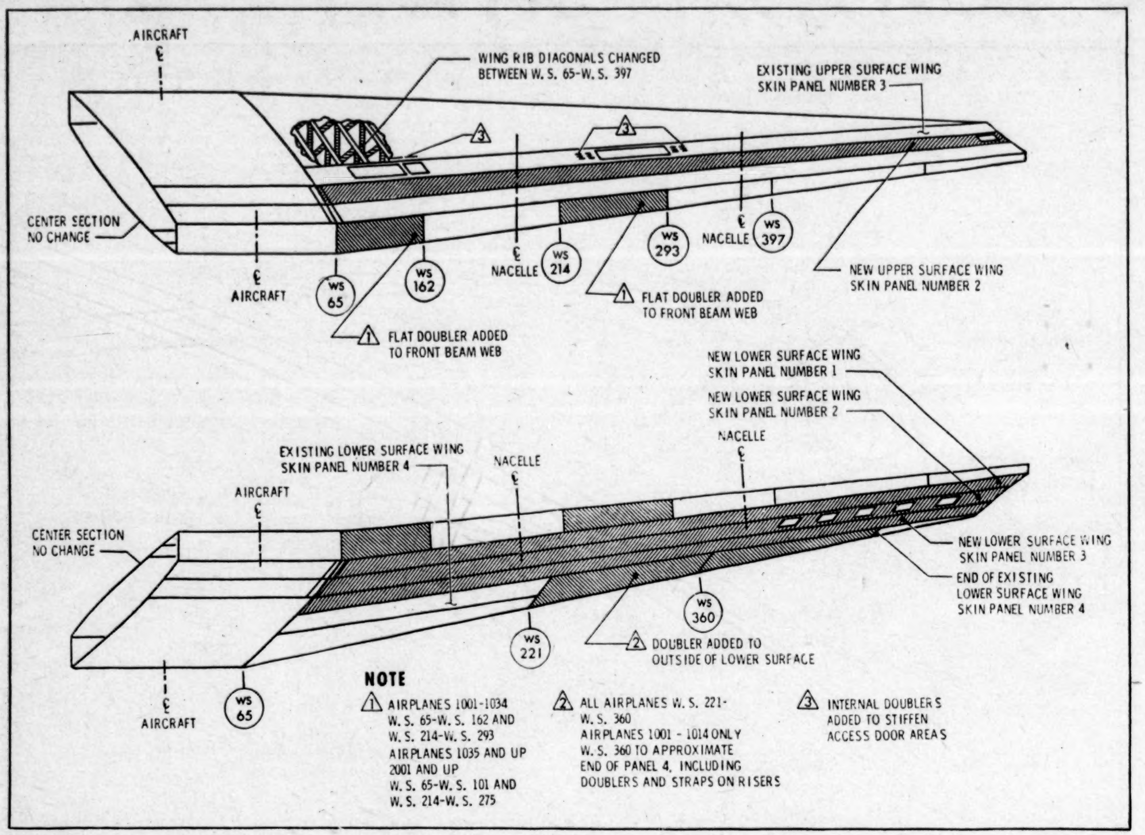
First problem was to change the structure of the powerplant installation so that the "whirl mode" would no longer be a menace. This was done primarily by adding structural members and strengthening existing structure. Four auxiliary engine mounts were added to brace the engine and three to support the gear box. Two existing gearbox mounts were stiffened. A side mount was added at rear of engine.

Shell of the powerplant egg (called QEC for quick-engine-change structure) was stiffened by a V-brace replacing the single side diagonal, and by stiffening nose, top, bottom and side cowling panels.

Aft of the QEC structure, the nacelle itself was strengthened by changing longerons and fittings that transfer loads from the QEC into the wing.

Most of these changes are necessary in the outboard nacelle only because this is the critical powerplant in gust conditions. But for interchangeability, all changes are made in all four nacelles.

The added weight of the QEC and nacelle structure would normally call for modifications in the wing structure. But there was an overriding factor that came out of Lockheed's flight tests with


AIRCRAFT ℄
WING RIB DIAGONALS CHANGED BETWEEN W. S. 65–W. S. 397
EXISTING UPPER SURFACE WING SKIN PANEL NUMBER 3
3
3
CENTER SECTION NO CHANGE
℄ AIRCRAFT
WS 65
WS 162
℄ NACELLE
WS 214
WS 293
℄ NACELLE
WS 397
NEW UPPER SURFACE WING SKIN PANEL NUMBER 2
1 FLAT DOUBLER ADDED TO FRONT BEAM WEB
1 FLAT DOUBLER ADDED TO FRONT BEAM WEB
NEW LOWER SURFACE WING SKIN PANEL NUMBER 1
NEW LOWER SURFACE WING SKIN PANEL NUMBER 2
NACELLE ℄
EXISTING LOWER SURFACE WING SKIN PANEL NUMBER 4
NACELLE ℄
AIRCRAFT ℄
CENTER SECTION NO CHANGE
NEW LOWER SURFACE WING SKIN PANEL NUMBER 3
END OF EXISTING LOWER SURFACE WING SKIN PANEL NUMBER 4
WS 360
WS 221
2 DOUBLER ADDED TO OUTSIDE OF LOWER SURFACE
℄ AIRCRAFT
WS 65
NOTE
1 AIRPLANES 1001-1034 W. S. 65-W. S. 162 AND W. S. 214-W. S. 293 AIRPLANES 1035 AND UP 2001 AND UP W. S. 65-W. S. 101 AND W. S. 214-W. S. 275
2 ALL AIRPLANES W. S. 221-W. S. 360 AIRPLANES 1001 - 1014 ONLY W. S. 360 TO APPROXIMATE END OF PANEL 4, INCLUDING DOUBLERS AND STRAPS ON RISERS
3 INTERNAL DOUBLERS ADDED TO STIFFEN ACCESS DOOR AREAS

ELECTRA wing changes included new skin panels on all surfaces, doublers on beam web.

Electra 1001 that was pushed through the violent turbulence of the Sierra wave again and again by company test crews. These flights, made with a heavily-instrumented airplane, have yielded data which the FAA says ". . . will benefit the entire aviation industry in the development of methods of analyzing airplane stresses."

One of these benefits to industry had to do with the amplification of wing bending moments. A wing behaves differently under slowly applied or rapidly applied loads. If there is a high rate of loading, such as that caused by turbulence, the wing bending moments are amplified and are greater than they would be for the equal load applied steadily or slowly.

The Electra more than met current design standards and regulations. Both original and special flight tests showed that the bending amplification was comparable to piston-engine aircraft types.

But the recent flight tests also showed that wasn't enough in itself to guarantee strength comparable to piston-engine types, because significant differences in wing torsion could exist. The major reason for those differences comes from the dynamics of the outboard nacelle, particularly in the first bending mode.

Consequently, major changes were made to strengthen the wing in torsion. Two new upper surface skin panels have been fitted to outer panels and center section. Two more have been fitted to the lower surface of the center section, and three to the lower surface of the outer panels. Wing joint at the intersection of center section and outer panel has been strengthened, and doublers have been added to the web of the front beam. A skin doubler has been added to the lower surface near the trailing edge of the torsion box. Diagonals have been added to wing ribs. Extra clips and new fasteners on skin-to-rib joints have been added.

During the LEAP program, Lockheed engineers used all the traditional tools of their profession plus some new ones developed for the project. They had the wreckage for minute examination, plus a field inspection of all the Electras then delivered to the airlines, plus Electra 1077—an aircraft of about equal time to the Northwest plane that was lost—loaned to them by the airline for inspection and dynamic testing.

They re-analyzed the structure, repeated the stress analysis, fed equations into computers from one extreme of a parametric scale to the other. They had tests made of a dynamically similar model in the transonic dynamics tunnel at Langley Research Center of the National Aeronautics and Space Administration.

Earlier, in an unprecedented move, they had bundled off complete packages of engineering data to Boeing, Douglas, Convair and a British firm with a request for a check of the data. More than 40,000 engineering man-hours went into that effort alone, which proved finally that Lockheed's engineers had not dropped a decimal or slipped a slide rule anywhere.

Engineers from Allison Division of General Motors, manufacturers of the Electra's four Allison 501-D13 turboprop engines, plunged into the problem.

Staff engineers from the airline customers worked with Lockheed; specialists from the Federal Aviation Agency and the Civil Aeronautics Board contributed in their respective fields.

At one time, there were 350 men assigned to the job. About 250 of these were Lockheed engineers, who worked around the clock, seven days a week.

Operators of the Electra have lost money on the program, although their only expense in connection with LEAP has been the cost of ferrying the planes to and from Burbank for modification. The returned, modified Electras carry an increase of about 1,400 lb. in zero-fuel weight due to LEAP. Flight schedules were knocked awry, and will not return to their old form until each fleet has been delivered. One estimate of time lost by a major Electra operator was 2,000 flying hours per month.

There have been reports that one or more operators are trying to sell their Electras—American reportedly sold three Electras to Real Aerovias of Brazil. Carrier emphasis, however, appears to be in studying ways to get even greater utility out of the Electra through five-abreast seating, or airbus types of operation.

Further improvements are in the works at Lockheed, not as part of the LEAP program, but as part of their ideas on product improvement. One of these is the development of "soft gear," a rework of the landing-gear system to reduce the sharpness of landing loads.

Air France Planning Reduced Cargo Rates

Paris—Air France intends to meet cargo rate competition on North Atlantic routes when current tariffs expire April 10.

Michel de Villeneuve, Air France sales director, said recently that the French carrier seeks government approval for a new cargo rate schedule on the North Atlantic. The Air France official said such rates will meet "open rate" conditions on the North Atlantic. System being suggested is aimed more at meeting competition from U. S. carriers rather than reflecting Air France thinking on this subject.

Air France general cargo rate proposals would be applied this way between France and the U. S. and Canada:

- **Shipments** running from 45 kilograms (about 100 lb.) to 99 kg. will carry a rate of $1.52 per kg., a reduction of 49% from the current rate.
- **Shipments** running from 100 kg. to 299 kg. will be rated at $1.14 per kg., a reduction of 62%.
- **Shipments** running from 300 kg. to 499 kg. will be rated at 72 cents per kg., a reduction of 76% from the present rate.
- **Shipments** of 500 kg. minimum will carry a rate of 66 cents per kg., a reduction of 78%.

Havana Issue Might Delay Soviet Bilateral

By L. L. Doty

Washington—Chances are strong that the U. S. and the Soviet Union will open talks on a bilateral air transport agreement this spring, but that Russian demands to include Havana as an intermediate stop will delay a final agreement.

Opening gesture last month by the Kennedy Administration—an invitation to discuss the exchange of air services—coinciding with moves by the Russian Embassy here to take soundings on the U. S. attitude, will undoubtedly bring about the first formal talks the two nations have ever conducted on a mutual trade of routes.

Plans to open negotiations last year were canceled by President Eisenhower in July after the Russians shot down a U. S. RB-47 reconnaissance aircraft over the Barents Sea.

Probable Outcome

If an agreement is reached, a simple New York-Moscow route exchange appears to be the only possible outcome of the talks. The U. S. will counter Russian demands for the Havana stop with demands for Fifth Freedom rights beyond Moscow to Tokyo across Siberia, which will either throw the talks into deadlock or terminate negotiations with a compromise direct route between the two countries.

The Russians believe they can operate the Havana-Moscow segment of the route with the long-range Tu-114 turboprop transport, but they are willing to concede an intermediate stop at Reykjavik, Iceland, as a refueling point on the U. S. route.

Return of the two surviving pilots of the RB-47 from Russian custody earlier this year has warmed Russian-U. S. relations sufficiently to permit revived planning of the talks. The Russians apparently have never lost their enthusiasm for the U. S. route—in line with the policy of Aeroflot to expand its international routes and especially to provide direct service to major foreign cities with Russian-built transports. However, the expansion is not being developed without hard-bargaining tactics on the part of the Russians.

Embassy Probing

Apparently the Russian Embassy has been under instructions for several weeks from the Kremlin to explore the congressional attitude on both disarmament and bilateral air transport issues. The Kennedy proposal evoked affirmative response from the Russians, along with the suggestion of Havana or Havana and Reykjavik as stops on the route.

The new Administration is placing a high priority on the proposed bilateral pact with Russia as well as on the overall international civil aviation problem. However, the Russian bilateral issue stands apart from other bilateral agreements with other countries since the economics of the proposed Russian agreement are, at this point at least, a minor consideration in view of the serious foreign policy implications involved.

Nevertheless, bilateral air transport agreements with other nations are drawing more attention within the new Administration than they had under the Eisenhower Administration. In fact, a four-way power play now appears to be emerging, with the Civil Aeronautics Board, Federal Aviation Agency, State Department and the White House each jockeying for a strong, active role in development of the Administration's plans to evolve a new international civil air transport policy.

Latest move was an invitation by the Kennedy Administration to the Dutch government to resume talks on KLM's bid for a route to Los Angeles. President Eisenhower made a similar invitation to The Hague during the closing hours of his term but reversed his decision to give the Dutch their desired route on advice from the Treasury Department, which was alarmed at the decline of U. S. gold reserves.

Policy Study

At the present time, the White House is giving serious thought to undertaking a study, through a consultant firm, of international aviation policy (see p. 47). Decision whether to go ahead with such a program has been held up for several weeks, but if it is conducted, bilateral negotiations in all areas could be delayed a number of months pending the outcome of the study.

Observers here do not expect the U. S. to win operating rights from New York to Moscow and beyond over Siberia. The Russians were willing to sacrifice an Aeroflot route to Tokyo rather than give the Japanese rights to cross Siberia.

In all but one of the bilateral agreements Russia has signed with nations outside the Communist sphere, no Fifth Freedom rights have been granted by the Russians. Nearly all air routes to the Soviet Union stop abruptly at Moscow. Fifth Freedom is the right of a carrier of one nation to fly traffic from a second country to a third country.

The one exception in which Fifth Freedom rights have been granted to another country is the agreement the Soviet Union signed with India. Implicit in this pact is the right to carry traffic from New Delhi to Moscow and beyond to London and even to New York.

India is expected to make a bid for this route in the near future under the terms of the agreement and, if Russia should be awarded a route to New York, it is considered very likely that it will grant the through operating rights to India, which would give both countries the shortest route between western Europe and the Far East. Air routes flown by all other carriers follow ancient trade routes through the Middle East, across India and around the coast of China. A great circle route across Siberia would slice 2,500 mi. from the present London-Tokyo flight.

Bargaining Wedge

Fifth Freedom rights beyond Moscow for the U. S., however, can serve as a bargaining wedge against Russia's demands for the Havana stop on the New York-Moscow route. And the Havana stop can serve as a weapon to knock down U. S. demands for the privilege of flying east of Moscow. There is nothing to stop the Russians from bargaining with the Cuban government for a direct Moscow-Havana route under a bilateral arrangement.

In any event, the two demands could create deadlocked negotiations until both governments determine whether the value of a reciprocal air route between the two countries outweighs the extra route benefits. Rights beyond Moscow for the U. S. would change the economic aspects of the operation for Pan American World Airways, U. S. carrier certificated to operate the route, from a very marginal operation to one of major significance. Service to New York through Havana would be of immeasurable assistance to Russia in strengthening its foothold in the Caribbean area.

White House Role

During the negotiations, the White House will virtually dictate points and issues to be raised and will maintain constant surveillance over the talks. The potential economic benefits to Pan American will not bear a strong influence on decisions, but the importance of a direct New York-Moscow route to relations with the Soviet Union will determine whether the U. S. is ready to settle for the simple route or battle for the longer route as a method of setting a future precedent.

Monroney Increasingly Critical of FAA

By Robert H. Cook

Washington—Sen. A. S. Mike Monroney (D.-Okla.) made it clear last week that he intends to keep a closer, more critical eye on the Federal Aviation Agency as his Senate aviation subcommittee continued its investigation of air safety.

Strong backing by Sen. Monroney of many Air Line Pilots Assn. recommendations, along with frequent criticism of FAA, made it clear that he has some misgivings about the uncritical support he gave the agency during its first two years and that he intends to keep FAA's operations under close surveillance.

Continuing to concentrate on methods of reducing the aircraft accident rate in terminal areas, subcommittee members concentrated most of their questions on an Air Line Pilots Assn. survey which claims that nearly half of the 569 U. S. airports lack sufficient landing and takeoff aids to assure safe aircraft operations.

The report triggered heated protests from the Federal Aviation Agency, which questioned its validity and asserted that the agency must "draw the line somewhere" in exercising its powers over airports, since many localities are unable to finance anything more than a minimum of improvement.

Commending ALPA on its testimony and survey, Sen. Monroney again raised the issue of whether FAA has exerted its full powers to promote air safety, and commented, "this is not a very good record. I don't think we're doing a good job."

At the same time, he took issue with the pilots over the speed of turbojet aircraft entering holding patterns and over a new FAA proposal requiring pilots to report any inflight navigational aid failures to ground controllers.

In a discussion of the United Air Lines DC-8 and Trans World Airlines Super Constellation midair collision over New York, Sen. Monroney rejected ALPA objections that reporting radio malfunctions to FAA would be too much of a communications burden to the aircraft crew and noted that, while the United pilot reported the loss of an omnirange receiver to the company, the problem was not reported to FAA controllers who might have prevented the aircraft from missing its assigned holding pattern and "flying into one way traffic" at another.

Speed of turbojet aircraft approaching holding patterns should be sharply reduced, "at least 2 or 3 min. in advance," he said, to provide a greater margin of flight safety.

"After all," he added, "holding patterns are much like an aerial stop sign."

To avoid the possibility of any more midair collisions over high density traffic areas, Monroney urged that FAA close the present "gap" in radar coverage by placing all aircraft in holding patterns under positive radar control. Existing FAA procedures provide this service only when flights are approaching or leaving holding patterns.

James T. Pyle, deputy FAA administrator, replied that the agency has been testing this idea for several months at its Atlantic City experimental center. Preliminary cost studies of extending this coverage to 25 high-volume traffic areas indicate it would cost an added $3 million a year, he said.

An FAA report that New York's three major air terminals, Idlewild, LaGuardia, and Newark, handle as many as 259 flights an hour at peak times prompted Sen. Monroney to agree with ALPA that establishment of a single communications control center for the entire New York area might eliminate much of the existing communications confusion. A permanent solution to the problem, he said, might require a new New York area airport.

Pointing out that 80% of aircraft accidents occur in terminal areas, he asked FAA why the agency does not certificate airports in the same manner as it does air carrier operations and airmen.

Current FAA regulations governing air carrier operations into airports have much the same effect as a direct certification of the airport, Pyle said, since the airports must provide a minimum of facilities necessary to assure that the aircraft can meet FAA safety standards. Any pressure for more than a minimum of equipment, he said, has been impeded in the past because many localities can not raise sufficient matching funds to purchase and install additional facilities.

The validity of ALPA's survey figures also came under heavy fire from FAA after Sen. Monroney quoted several sections of the pilots' study highlighting a deficiency in landing and takeoff aids which ALPA considers necessary for air safety. One portion of the 257 airport survey claims that only 4% of current airports have runway visual range facilities available, and only 8% of all airports plan to install them.

Pyle contested several of the figures as "inaccurate" and pointed out that runway visual range units are planned for all instrument landing systems under a program now being conducted with the U. S. Weather Bureau. A total of 18 have already been installed, he reported, 31 more will be installed by the end of this year and more than 130 are planned for the following year. FAA asked an opportunity to make a full study of the ALPA survey.

FAA also took the defensive against the pilots' demands for more "under run and over run" area on runways. FAA certification of such turbojet transports as the Boeing 707 and turboprop aircraft such as the Lockheed Electra, has been conducted under ideal weather conditions with professional test pilots at the controls, the union contended, so the true operating characteristics of the aircraft are not discovered until they are in scheduled service.

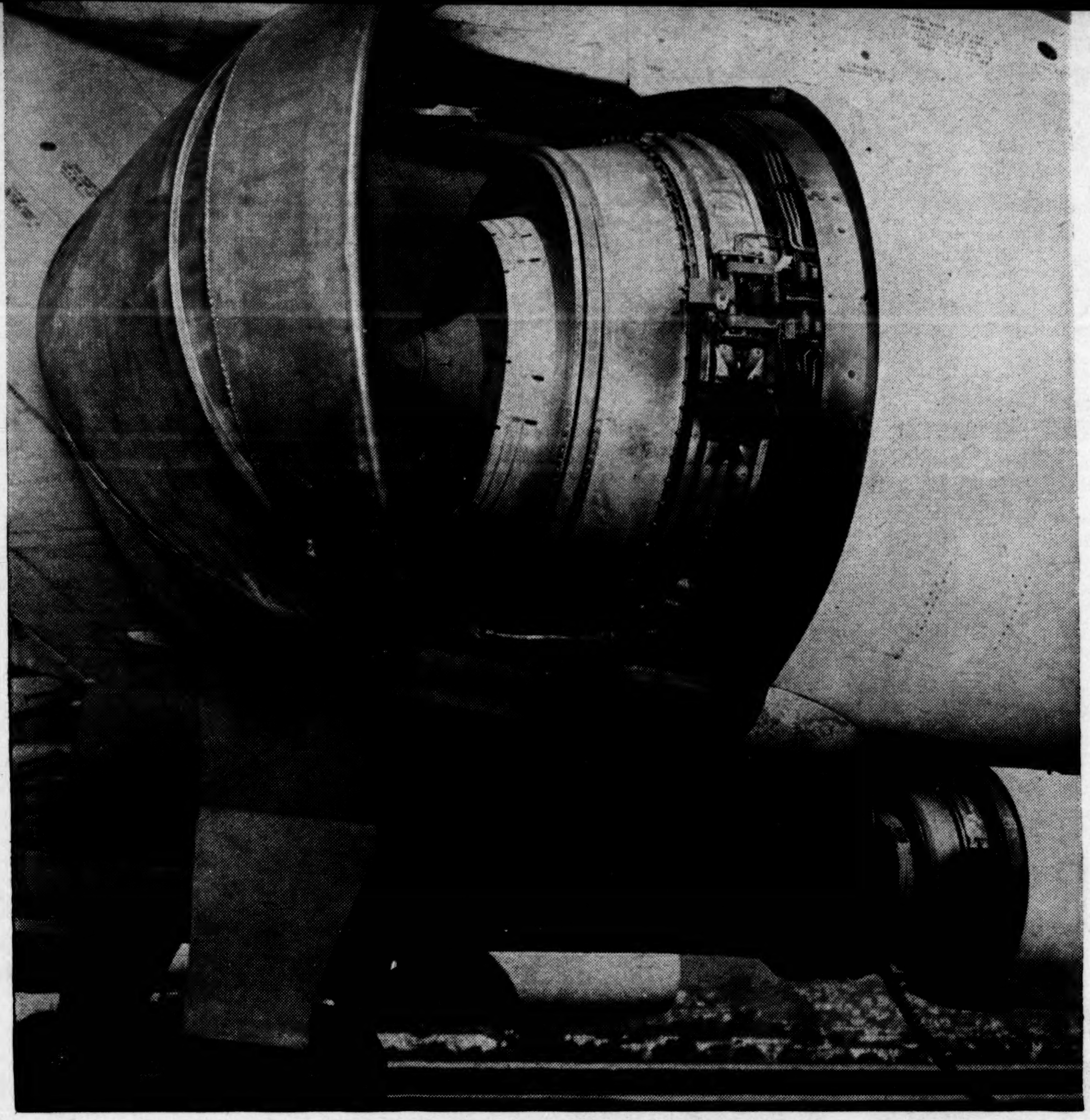
Because of demonstrated high sink rates on flare out and high touchdown speeds, ALPA said runways should be lengthened at both ends by one tenth of their lengths and widened two thirds, to provide a compacted earth support as a protection against under or overshooting landings and skidding off runways.

Pointing out that FAA does not have the authority to finance such extensions, Pyle said the agency's present regulations on one-engine-out takeoffs and clearance of a 50-ft. obstacle at the end of runways have the effect of providing this extra margin, since landing aircraft crossing the runway threshold at a 50-ft. altitude are required to demonstrate they can stop within 60% of the runway length. The American Airlines Electra which hit an 8-ft. dike while landing at LaGuardia last Sept. 16 should have cleared the obstacle by 70 ft., Pyle contended.

Although the runway had less than 5,000 ft. of usable length because of construction on the field, Pyle said the aircraft is capable of completing a landing in less than 6,000 ft. without reverse thrust. Application of reverse thrust, he added, should permit the aircraft to land in less than 4,000 ft.

Sen. Monroney's reply to the FAA was that "this seems to require more than a possible defense that the present regulations are all right. These are heavier, high performance aircraft." He added that it might be wrong to criticize airport authorities for failing to provide this type of extra protection, and that it should be the duty of Congress to provide the funds for this work.

FAA told the subcommittee that the agency conducts a semiannual check on airports, in addition to requiring spot checks by en route flight inspectors. Many of the items listed as deficient by ALPA, the agency said, would not be considered so by FAA, which requires airports to install only the facilities considered reasonable.



Convair 990 Has Clamshell Thrust Reversers

Thrust reverser on first Convair 990 transport's General Electric CJ-805-23 aft-fan jet engine has clamshell doors which reverse primary jet efflux through inner nozzle, and fan air which is ejected through outer concentric nozzle. Clamshell doors on General Electric's reverser form engine pod's aft external surface during cruise. Convair's first 990 has completed approximately half its scheduled taxi tests (AW Feb. 13, p. 48).

Baseball Teams' Airline Travel Affected by Transition to Jets

By Glenn Garrison

New York—Travel habits of major league baseball teams are being changed by the airlines' transition to jets, with a sharp decrease in aircraft available for charter.

Last year most of the clubs' air travel was in chartered piston equipment. This year, only an estimated one-third of the air travel will be in charters and the rest will be flown in scheduled jet equipment.

Airlines handling the teams' long-haul trips have sold some of their piston planes and others are being used on lesser routes. Although the baseball clubs prefer charters because of their flexibility, jets are not economical or often available for such charters, and piston equipment is scarce for this purpose.

United Air Lines, leader in the baseball air travel market, estimates that it provided about 85% of all air transportation for the major league teams last year. Most of the business was in chartered aircraft.

This year, United expects to be the primary operator in the field again, but most of the clubs will be using scheduled jet flights. According to Robert Procuniar, United's Chicago account executive for sports, the airline already has booked about 92 jet trips for the teams for the coming season. Industry-wide, the total stands at more than 100 jet trips.

United will have less control over the market this year, however, since routes and schedules will in part determine the choice of carrier.

The imminent merger of United and Capital Airlines is another factor in United's shortage of equipment for charters. Expected to go through some time this spring, the merger will bring a need for United four-engine piston equipment to cover some former Capital routes.

The clubs prefer charters because they do not involve rigid departure times. In some cases, using scheduled flights may cause a situation where, if a game goes into extra innings or is delayed for other reasons, the flight will be missed and possibly a long layover is necessary. Under consideration by the clubs is the possibility of time-limiting the games where these circumstances prevail. When the teams use trains, such limits have been imposed by some teams in the past.

Teams using scheduled flights block off an entire first class section. On United's DC-8s, this normally means 40 seats plus lounge which the team has all to itself. The usual team contingent consists of about 40 people.

Expansion of the leagues this year has brought the number of teams to 18, boosting the travel requirements. The Chicago White Sox, for example, have averaged about 15,000 air miles a year in the past, according to Procuniar. With the expansion, the current request involves 26,122 air miles. With a normal 40-passenger total, this would mean 1,044,000 revenue passenger miles for the year from the White Sox alone.

This team, incidentally, will be making about the longest possible domestic jet trip—the 2,600 air miles from Los Angeles to Boston.

For short-haul travel, the teams use chartered bus or train. In the National League, for example, travel by bus is the customary means of travel between Milwaukee and Chicago.

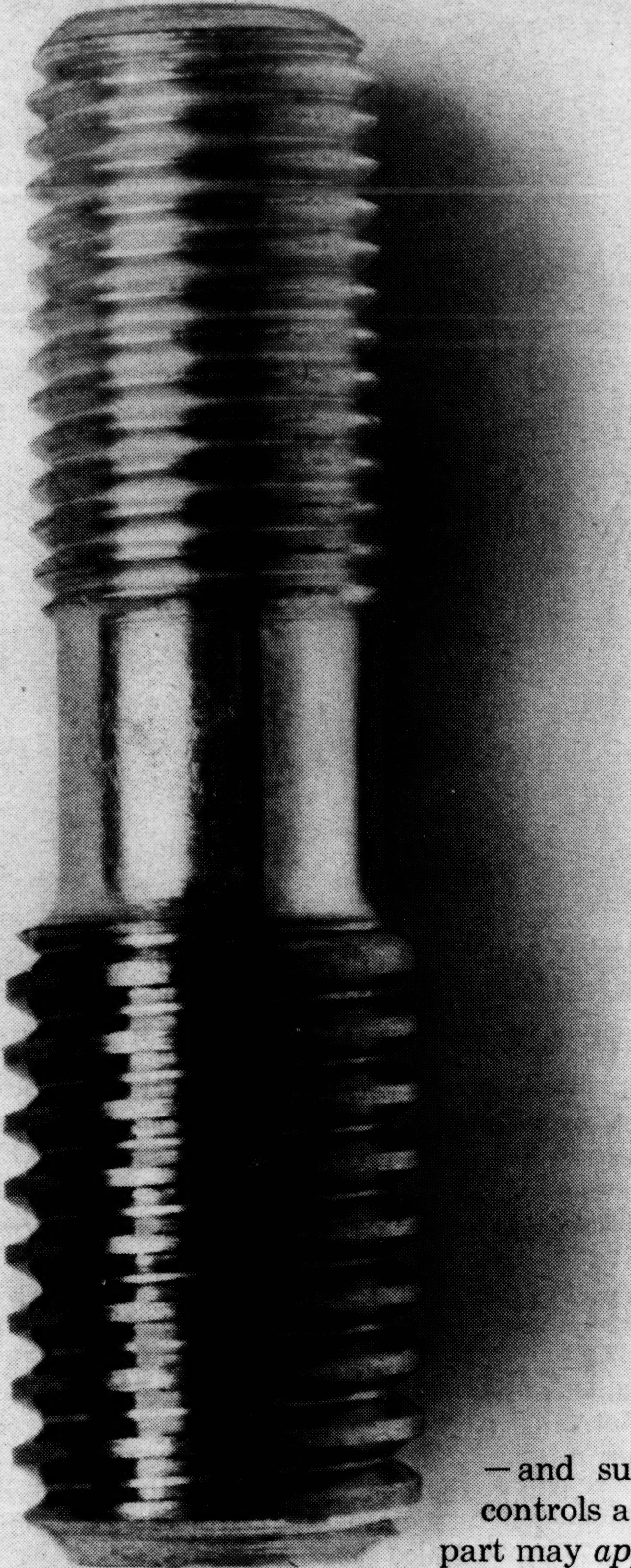
According to one industry source, the baseball teams prefer first-class travel and this is another reason suitable charter equipment is in short supply. Some aircraft that might be available are in coach configuration, hence unsuitable.

American Airlines is another operator of baseball charters, being active in the field in 1959. Last year, however, American's equipment situation precluded activity in the field. This year, American has booked some clubs on scheduled flights, and may sandwich charters in over certain segments.

Trans World Airlines will operate a few baseball charters this year, using Lockheed 049 Constellation equipment. TWA also will participate in the movement of teams by jet.

United pursues the sports charter business aggressively, maintaining special sports representatives at various stations. Baseball teams, the airline notes, are more adaptable to the transition from charter to jet transports than football teams. Reason: the number of persons normally involved, which is about 55 in the case of the football contingents. This means that, unlike the baseball clubs, they can't take complete occupancy of a jet section all to themselves, but would have to spill over into the tourist compartment.

According to United, all the major league teams use air at least to some extent. Most of them use air travel primarily for long trips, but the Yankees last year made only about nine air trips, the rest by rail.



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CAB Plans to Abolish Cargo Rate Minimums

Washington—Civil Aeronautics Board cleared the way for industry-wide experiments with lower air cargo rates last week by proposing abandonment of its 12-year control over minimum freight rates.

Noting that it is convinced that the industry is about to "enter a new era" in cargo business, the Board said it was prompted to make the proposal because of the large number of turbine-powered cargo aircraft now on order, the conversion by domestic trunklines of surplus piston aircraft to cargo use and the added cargo capacity of passenger turbojets, all of which will produce a heavy increase in over-all airfreight capacity.

In order to generate sufficient cargo volume to meet this expanded capacity, CAB said, the industry should have "maximum flexibility" to experiment with promotional rates designed to increase air cargo traffic. The Board added that the present rate floor is now obsolete and was imposed at a time when the industry was involved in a rate war. The position of the various airlines since then has changed to the point where present cargo rates are generally above the prescribed minimums, the CAB order noted.

While its proposal lifts a major restriction from the cargo industry, CAB pointed out that carriers would still be required to file tariffs, which would be subject to investigation or suspension by the Board if considered unjust or inadequate. Interested parties have until Mar. 16 to comment on the proposal.

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Orly Airport Terminal Unveiled

New Orly Airport terminal, the largest in Europe, has 15 escalators and 12 large elevators to transport passengers through the facility. To ease passenger flow, baggage is handled on the ground floor while passenger access to aircraft is on the floor above.

Service Normal on Six Of Seven Struck Lines

Six of seven major airlines paralyzed by the recent wildcat strike of flight engineers, protesting the National Mediation Board's proposed merger of pilot and engineer unions, were back in full service early last week.

Pan American, National, Trans World, Eastern, Flying Tiger and American Airlines reported complete restoration of service by Tuesday. Only Western Air Lines, which refused to take part in President Kennedy's peace plan and 90-day cooling off period, remained severely curtailed late last week.

Western Air Lines elected to go its own way and refused to promise Labor Secretary Arthur J. Goldberg that striking Flight Engineers International Assn. members would be immune from company disciplinary action. Western fired its striking engineers and started hiring pilot-trained engineers to cope with steadily dwindling flights, which fell from an average of 86 per day to a complete shutdown at the peak of the walkout. Since then, Western has operated only a few flights in the Rocky Mountain area. Some flights were slated to resume Mar. 2, but beyond that, Western has not stated its plans.

The return to work during the 90-day truce was followed by a new strike legislation proposal by Sens. Jacob K. Javits (R.-N.Y.) and George D. Aiken (R.-Vt.) authorizing the President to declare a state of emergency and then seek court action allowing a receiver to operate an industry in strikes affecting the nation's health and safety. Sen. Javits introduced the legislation last year prior to the New York tugboat strike, but the FEIA walkout "certainly prompted" expansion of the bill to include situations not covered by the Railway Labor Act.

The strike ended Feb. 24 after White House intervention, and Pan American and National were in partial service the following day. Pan American, TWA domestic services, American and Eastern were in full operation by Sunday, Flying Tiger by Monday and National and TWA international schedules were in full service by Tuesday.

In another strike, the dispute between Northwest Airlines and its engineers represented by International Assn. of Machinists, President Kennedy invoked Section 10 of the Railway Labor Act, which calls for a 60-day truce while a three-man fact-finding board investigates and reports to the President in 30 days. Northwest, whose engineers walked off all aircraft Jan. 9, brought its aircraft out of storage last week.

New TWA Directors Hold First Meeting

New York—Trans World Airlines' newly re-constituted board of directors met for the first time here last Wednesday, probably to discuss, among other things, the formation of a committee to select a new president for the airline.

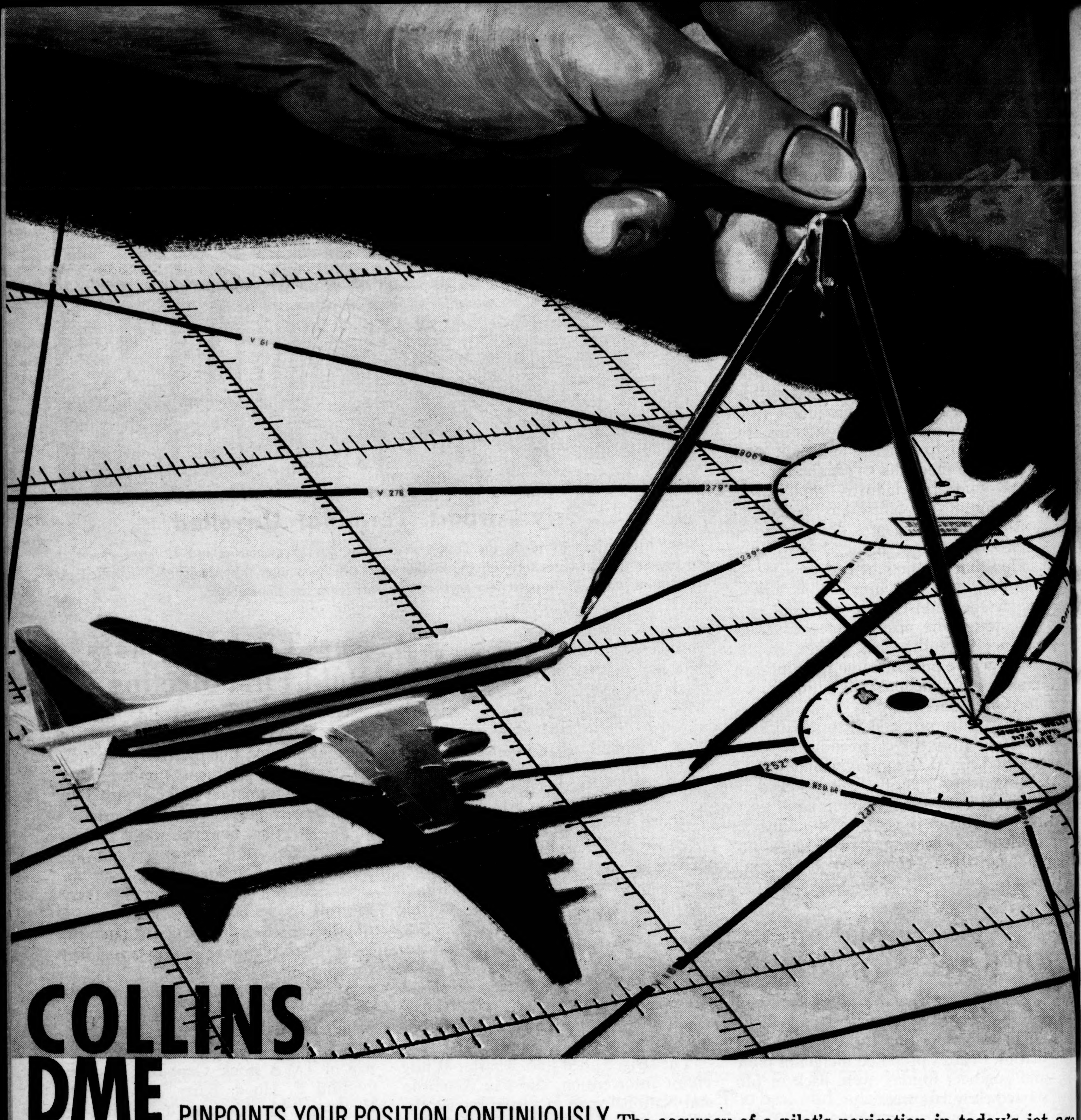
The meeting, however, was described as "routine" and there was no announcement of actions taken. The session replaced the regular February meeting of the board, canceled because of the engineers' strike last month. Next directors' meeting is scheduled for Mar. 30.

At a meeting of stockholders in Kansas City earlier last week, six new board members elected were Ernest R. Breech, who is one of the voting trustees of TWA stock; George R. Brown; Clifford F. Hood; Barry T. Leithead; Hughston M. McBain; and John A. McCone.

The stockholders re-elected 12 members of TWA's board.

Lufthansa 727 Plans

Lufthansa German Airlines will use 12 Boeing 727 medium jet transports, purchase of which is still being negotiated, to increase Lufthansa's frequencies to major European and Near Eastern points (AW Dec. 12, p. 41) and might figure in still tentative route extensions planned for 1964-65. The 727s will serve most of the major European capitals and Beirut and Istanbul.



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SHORTLINES

▶**British Overseas Airways Corp.** plans to begin through service between Washington and London June 2 with four Boeing 707 round-trip flights weekly. Starting June 9, BOAC London flights will leave Friendship International Airport at 6:30 p.m., daily.

▶**Braniff International Airways** will double the number of coach seats available on all Electra flights. The new arrangement seats 30 tourist and 38 first-class passengers.

▶**Delta Air Lines** has installed Ticketeer, an automatic ticket printer operated by prepared matrices, in its Atlanta offices. Ticketeer is expected to save up to 50% preparation time by producing a ticket marked with destination, origination, class, fare and tax.

▶**Detroit's** two major airports report 1960 passenger arrivals and departures at 2.8 million, over twice the traffic handled in 1951.

▶**Eastern Air Lines** reports that its Air Bus traffic carried in December between Miami, Pittsburgh, Cleveland and St. Louis included 10% who were flying for the first time, 22% who usually drove between the same points and 22% who were housewives.

▶**Federal Aviation Agency** began operating a new 2-million words-per-day capacity Air Route Traffic Control Center last week in the crater of Diamond Head, an extinct volcano near Honolulu. The center will handle international air traffic control information and weather communications between Honolulu, the U. S. mainland and southeast Asia.

▶**Federal Aviation Agency** and Department of Commerce are training 4,000 specialists to provide preflight briefings and fill air-ground requests for late weather information at several hundred additional U. S. airports.

▶**Lake Central Airlines** added three Convair 340s to its all DC-3 fleet last week. The carrier now has 23 aircraft, an increase of 11 since December. At the same time, service was initiated at Washington, Baltimore, Marietta, Ohio and Parkersburg, W. Va.

▶**Mohawk Airlines** has been authorized by the Civil Aeronautics Board to fly between co-terminals Watertown and Ogdensburg-Massena, N. Y. and Pittsburgh via intermediate points Utica-Rome, Syracuse, Ithaca-Cortland, and Elmira-Corning, N. Y.

AIRLINE OBSERVER

▶ Kennedy Administration is considering a wide-scale study of all aspects of international air transportation as a first step toward establishing a new civil aviation policy. The study, if conducted, will encompass U. S. and foreign civil and military airlift operations and could take as long as a year to complete.

▶ Watch for restudy of Trans World Airlines equipment plans now that Howard Hughes' influence in management is curtailed. TWA has six positions reserved on the Convair 990 line, but there may be some question whether this is the right airplane for TWA's system. One of the first tasks TWA's new management will face will be to bring its jet fleet into balance with those of its transcontinental competitors, United and American. TWA officials are impressed with the Boeing 720B turbofan-powered transport, but the Boeing 727, Sud Caravelle and the de Havilland 121 Trident also are strong candidates.

▶ Time between overhaul on Pratt & Whitney JT3C-6 engines operated by Trans World Airlines and American Airlines has been increased from 1,600 hr. to 1,800 hr. by the Federal Aviation Agency.

▶ American Airlines sold three of its Lockheed Electra turboprop transports to Real Aerovias, Brazilian airline, last week. American now has 30 Electras left.

▶ Cost per hour flown during the recent certification program of the Boeing 720B turbofan transport is estimated at $5,000 to $7,000. Instead of the 300-hr. schedule originally planned, the program ran to nearly 600 hr. Certification of the Boeing 707-320B is scheduled for 150 hr.

▶ British European Airways' fleet of Comet 4Bs developed an unexpected nose wheel problem—nose wheel axles of two aircraft broke while taxiing, and axles of all BEA Comets have been sleeved as a corrective measure. Occurrence has been attributed to higher landing frequency of the BEA transports, since the defect did not appear on British Overseas Airways Corp. Comet 4s.

▶ Principal factor behind foreign air carrier opposition to U. S. carriers' bid for high volume breakpoints as a basis for a revised North Atlantic cargo tariff during the recent International Air Transport Assn. traffic conference (AW Feb. 20, p. 38) is air freight forwarder activity. One foreign flag carrier charged that U. S. carriers, with their larger cargo capacity, naturally would attract business from forwarders with the high volume breakpoint system. Many European carriers, with low capacity and no national freight consolidating industry, would be unable to meet the competition.

▶ Federal Aviation Agency has established an intermediate airway system and lowered the floor of the continental control area from 24,000 ft. to 14,500 ft. Intermediate system will provide a system of express airways for long- and medium-haul aircraft between 14,500 and 24,000 ft. High altitude system for turbojet aircraft is above 24,000 ft., low level system is below 14,500. As a result of the revised system, all traffic above 14,500 ft. will now be flying in controlled airspace over the continental U. S.

▶ New peak in scheduled Moscow-Paris air service is planned by Aeroflot and Air France this spring, despite somewhat chilly relations between Russia and France recently. Both carriers plan to offer daily flights, compared with five round trips weekly last summer and two round trips weekly when the Moscow-Paris service was inaugurated in 1958.

▶ President Kennedy last week urged Congress to retain revenues from taxes on aviation fuel in the General Fund rather than in the Highway Trust Fund which is current practice. In the General Fund, these fuel taxes could be applied against the cost of federal airways operations.

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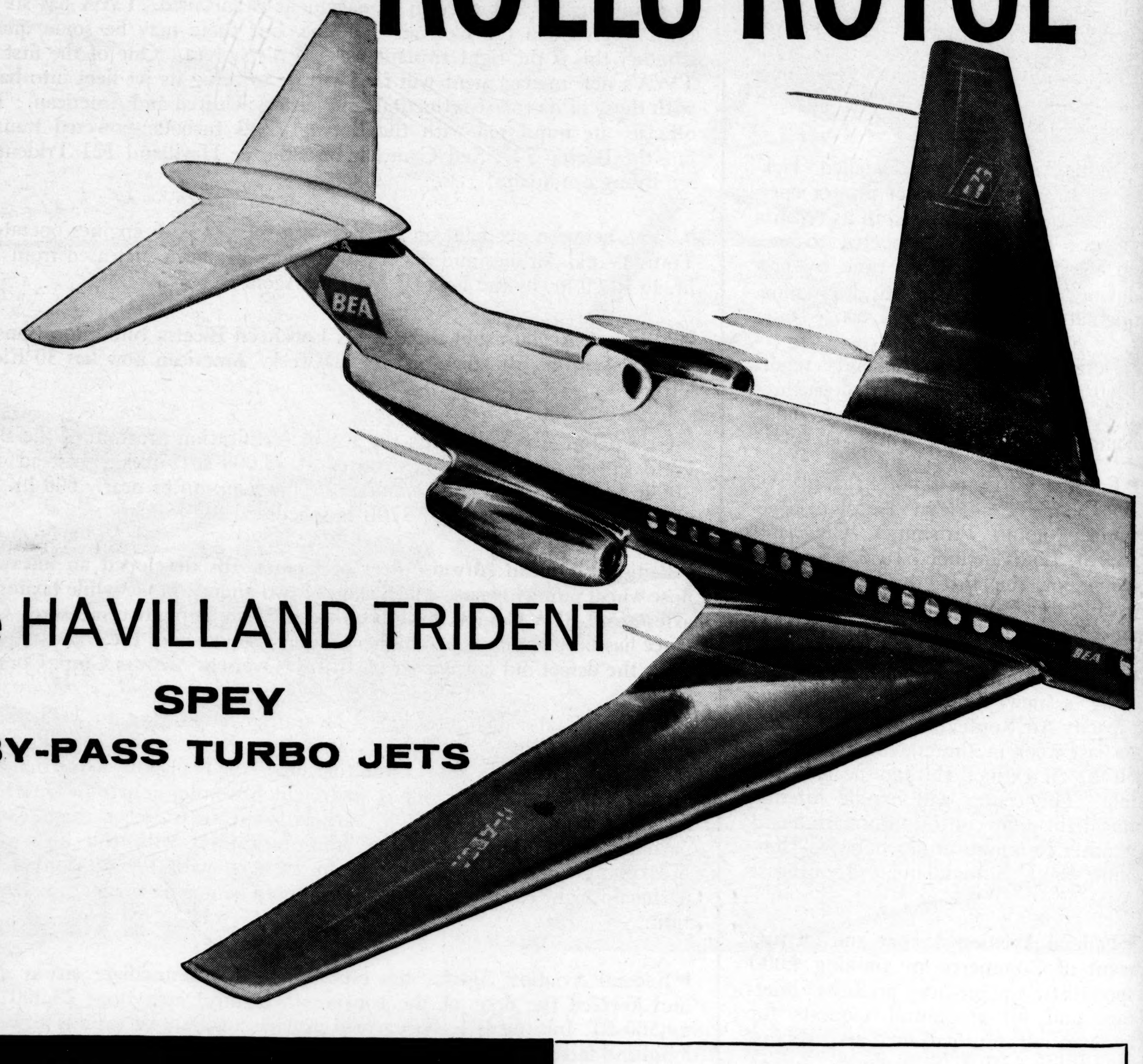
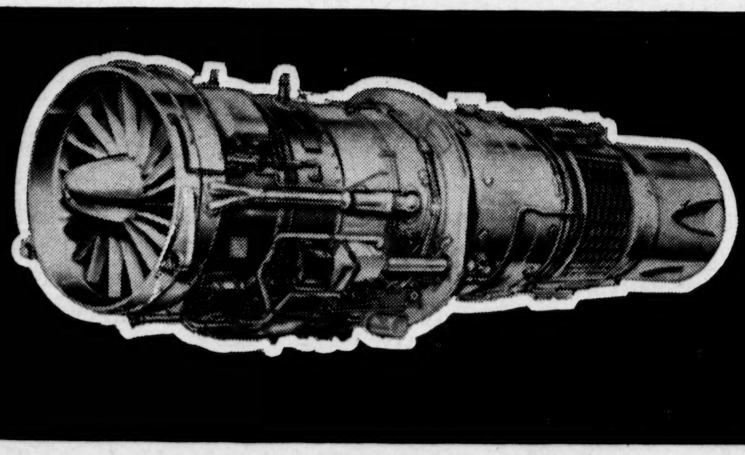


de HAVILLAND TRIDENT

SPEY
BY-PASS TURBO JETS



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Boyd Reaffirms Stand On Airline Mergers

Washington—Civil Aeronautics Board Chairman Alan S. Boyd last week reaffirmed his stand that mergers may be beneficial to the trunkline industry, but warned that the Board would not permit competitive patterns to "fade away" through mergers.

In his first speech since assuming the chairmanship last month, Boyd told the Washington Aero Club that the low earnings of the trunkline industry are a "great problem" that is the "Board's problem." He admitted that it is not entirely within the Board's powers to find solutions because of the effect the current recession has had on airline traffic activities, but added that the "Board cannot cross its fingers and hope for improvement."

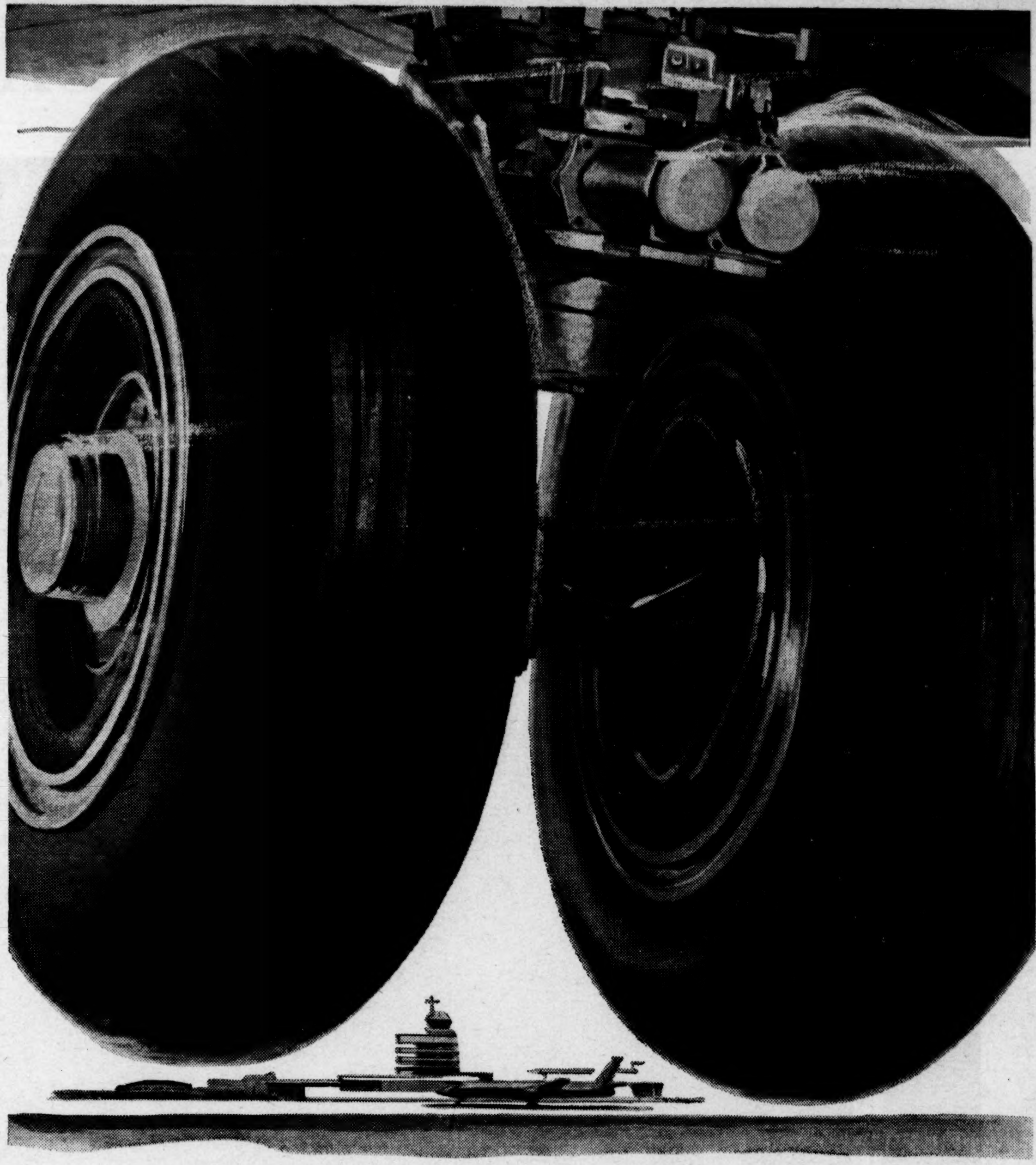
He said that if mergers are to be a part of the solution and balanced competition is to be preserved, it is the Board's responsibility "to develop the means to advise the industry what alternatives may be generally acceptable—and to do so fast." He added that such advice as the Board might give may be "less than welcome" to contemporary prospective merger parties.

Boyd emphasized that the nation "must develop" a Mach 3 supersonic jet transport, adding that carrier earnings are the "only hope for a substantial private enterprise contribution to supersonic transport development." He said that recent experiences in introducing turbojet aircraft should "teach us a painful lesson that we are not too early, if in fact early enough, to begin serious planning for the supersonic age."

Discussing the international field, Boyd called for a revision of U.S. policy toward route exchanges and capacity. He warned that unless some "rethinking" is done in this area, clashes between the U.S. and foreign interests will become more acute and difficult.

Boyd promised a prompt re-examination of the Board's organization and gave his assurances that "where change is needed to enable the Board to cope with the problems of today—and those anticipated for tomorrow—changes will be made—and made promptly."

He said he wants to see the Board organized and staffed for the jobs ahead and added that he hopes to see "Board members themselves freed . . . to spend greater time themselves on policy and procedural planning, more time on the needs of the industry and the public at large, rather than on individual carriers, individual cities, and in all too many cases, on individual flights."



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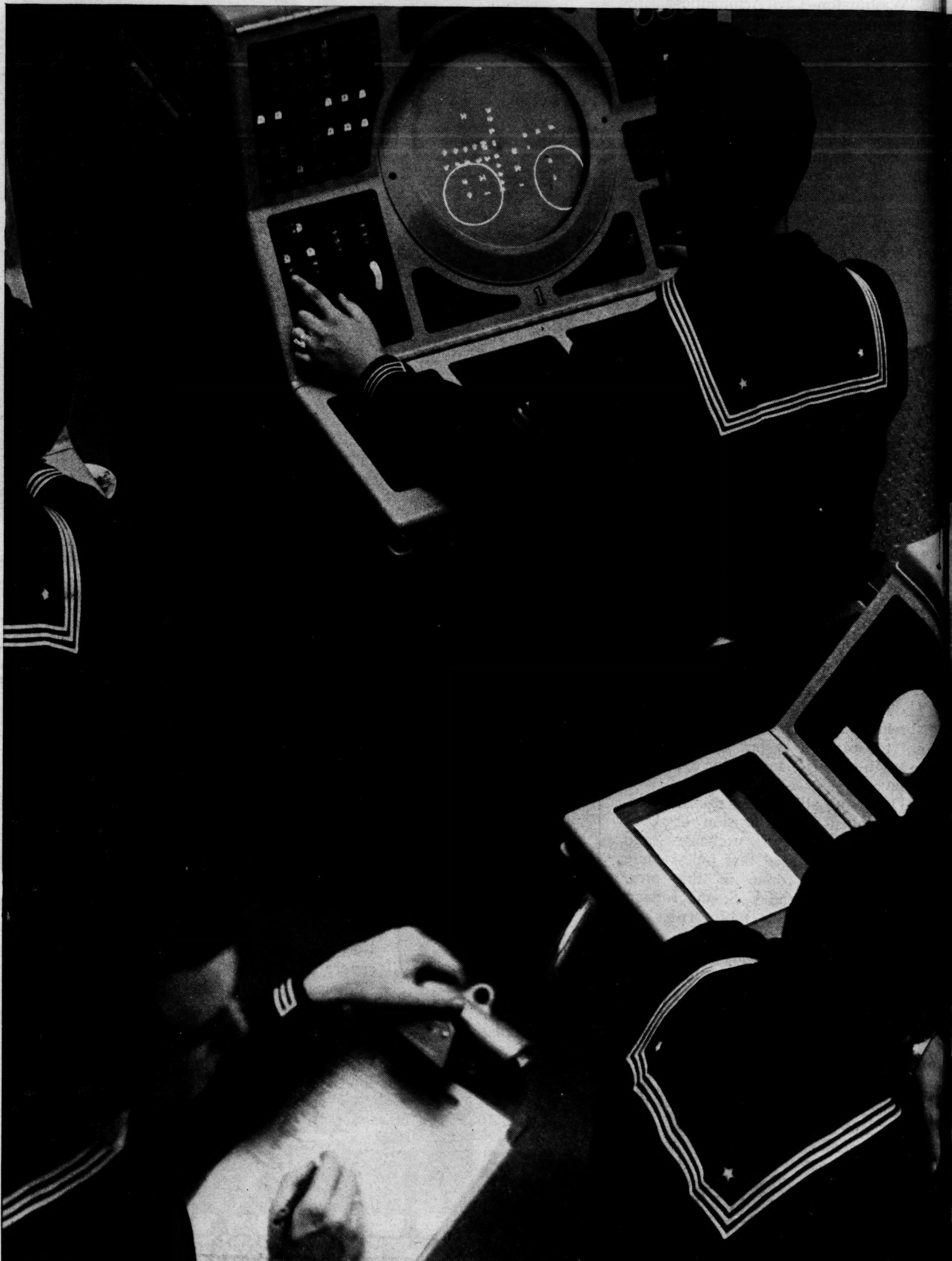

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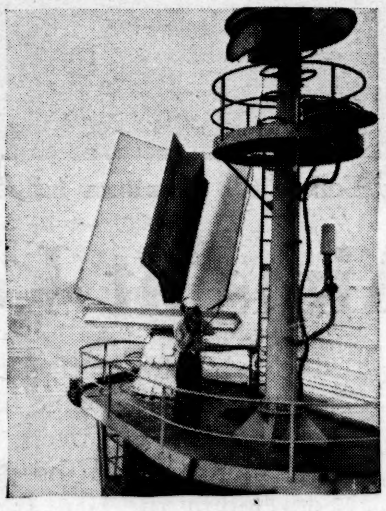

High over the deck of the missile cruiser USS Galveston, this new Hughes 3-D radar antenna simultaneously detects the range, bearing and altitude of a great number of targets. The sailor shows comparative size.

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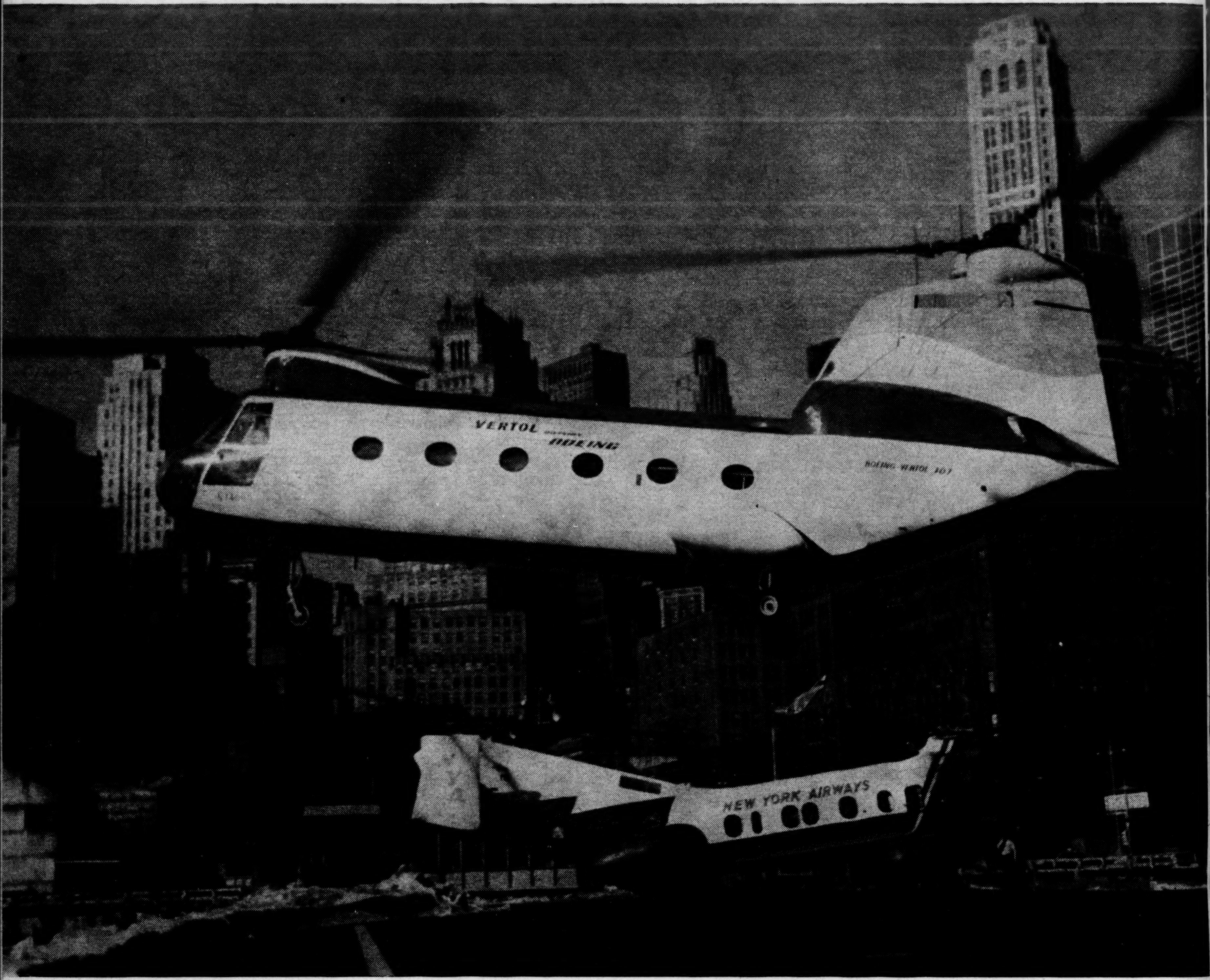


PROTOTYPE Vertol 107 hovers over New York City's downtown heliport. New York Airways Vertol 44 is in background.

Vertol 107 Aims at Low-Cost Versatility

By David A. Anderton

Morton, Pa.—Selection of the Vertol 107M by the U. S. Marine Corps marks a major turning-point in the five-year development program of this "mission-module" helicopter.

Observers of the hotly contested competition for an assault helicopter believe the Vertol design was chosen over its competition on the basis of ". . . both technical reasons and cost."

The crowning touch for Vertol was that the Marines' specifications had originally been written largely around a competing helicopter—"Brand X" as the Vertol engineers refer to the type.

To Vertol management, winning the competition justified the large investment of company funds that had gotten the twin-rotor craft out of the drawing stage and into flyable machinery.

To Vertol engineers, the choice came as vindication of the long hours spent developing the 107. It was a helicopter that was not right the first time, and Vertol's project team had the courage to admit that and had the stimulus and backing to do something about it.

Status Report

What they did turned out to be a basic helicopter which in one version won a tough competition for a combat role in the Marines' vertical-envelopment concept. Another version has been sold—five firm and five optioned—to New York Airways as a 25-passenger transport for that carrier's routes around the New York area. Sale of an additional block of 10 Model II helicopters to Kawasaki Aircraft Co. of Japan was announced last week. Two of these 10 will be the basic airliner configuration and will be delivered as complete aircraft with flight testing done at Vertol. The remaining eight will be delivered in kit form for assembly by Kawasaki, Vertol's licensee in Japan.

A design variant is being studied to increase helicopter speeds by an extrapolation of current aerodynamic tricks. There are others on the boards, in brochures and in the minds of Vertol designers.

Two of the Army's YHC-1As, bailed back to Vertol and modified to Model II standards for the Federal Aviation Agency certification program, have accumulated about 80 hr. flight time toward that goal. This includes Vertol's time leading to the certification flight testing.

Together the prototype 107 and the YHC-1As have 824 hr. of flying time. The prototype has made about 1,000 water landings to demonstrate the flotation capabilities of the sealed fuselage.

Vertol's 107 carries a slab-sided storage space 6 x 6 x 24 ft., faired into a side-by-side cockpit forward and a beaver-tail ramp aft. Two three-bladed, synchronized, partially overlapping rotors are mounted on pylons above this 864-cu.-ft. cabin. Twin General Electric T58 turboshaft engines are mounted side-by-side in the rear pylon. There are the usual doors, windows, controls and landing gear. Two sponsons jut out from the fuselage just above the rear wheels and carry all the fuel. The fuselage is sealed for water landings.

This is a conventional catalog of technical features. But Vertol's engineers went about the design in some unconventional ways, and did some unconventional things to the helicopter.

Cost Control

Primarily they wanted to reduce costs throughout the aircraft, both the initial cost of the helicopter and its equipment, and the direct operating costs and maintenance charges against the ship in service.

One of the first approaches to tight cost control saw four experienced field-service engineers transferred to the project office with instructions to monitor everything that could possibly affect maintenance. These four were armed with the power to approve or disapprove engineering drawings.

Another step was to spread the contents of an Army mechanic's standard toolbox on a wall display board in the engineering department. These are the tools you design for, engineers were told. If you can't, and have to figure out a special tool for the job, you'd better have an awfully good reason to justify the extra cost.

There was a fixed policy on Vertol 107 maintenance adopted: all work platforms and access to them had to be integral parts of the aircraft. There was to be no need for ladders or external work structures. Another item: all maintenance had to be done from outside the aircraft where possible; everything had to open for work without the need to disturb the interior of the cabin.

Complexity of structure was hit hard. Continued emphasis on simplification of mechanical design paid off; to prove it, somebody made a count of the number of individual metal parts in the 107. Compared with its predecessor, the H-21 of equal empty weight, the 107 has 40% fewer parts.

Producibility followed complexity-consciousness. The large volume of production on the H-21 had set some fairly low unit costs on the airframe. But Vertol engineers set more stringent requirements for the 107. There were fewer parts to begin with. Production engineers saw that parts were designed for assembly after fabrication with no hand work on the parts and no intermediate step of "hammer-to-fit" operations.

The third cost-cutting item was a careful analysis of everything bought from vendors. Procurement of subcontracted or stock parts from outside sources was drastically cut back. Even rotor blades, which traditionally had been made for the company by Parsons, were fabricated at Vertol.

One result: unit cost of the first three YHC-1As was equal to the unit cost of the 150th H-21 off the line. One engineer estimated the 107 in production will cost 40% of a comparable conventional structural design.

"Functional design is one of the biggest features of the 107," said Norman C. Taylor, Vertol's chief engineer. "Right after that come flying qualities, low cost, maintenance and reliability."

With the tandem-rotor configuration of the 107, the total center of gravity range is 60 in., allowing almost completely indiscriminate loading of the entire payload. One design detail that appeals to the operator of short-haul routes is the baggage carrier, designed to plug in the open tail section of the fuselage like a cork into a bottle. This carrier can be pre-loaded while passengers are waiting, and then replaced by a full rack when that is off-loaded at the terminal. En route the container is rolled out for access from the ground on both sides. Bags can be hauled out and loaded, and the carrier then pushed back and locked in position.

The design aim was to reduce baggage ground-handling time to less than two minutes.

Passenger comfort was another design aim. Noise and vibration levels are directly comparable with the best fixed-wing transports today, says Taylor. The lower vibration level was attributed to the presence of only a single forcing frequency from the synchronized rotors, and to less flapping hinge offset. Measurements show vibration amplitudes to be well under 0.01 in. laterally and vertically for all airspeeds between hovering and about 135 kt.

Noise level inside the cabin has been measured by Bolt, Beranek and Newman to be about 67 db., with 68 db. for a four-turboprop fixed-wing transport cited as a comparative figure.

Outside the cabin, noise level of the 107 is well below that of other transports around the airport circuit. At 500-ft. altitude, the external noise level of the 107 is about 82 db.; at 1,000 ft. this has dropped to about 72 db., and at 1,500 ft., to about 67 db.

These figures, incidentally, are well below those for other forms of suburban transportation: an automobile at 20 ft. distance, an electric railroad at 100 ft., or a bus at 20 ft.

Emergency Techniques

Vertol's 107, in common with other multi-turbine-engine helicopters, does not have the limiting height-velocity restrictions of single-engine aircraft. This means optimum flight paths for takeoff and landings can be developed.

For the 107, one-engine failure at critical height and climb-out speed gives the pilot two choices: he can continue to climb on a 1:20 path to clear a 300-ft. obstacle in a distance of 2,400 ft., or he can descend to the heliport using the 2½-min. contingency rating of the remaining engine.

In confined spaces where the vertical or near-vertical takeoff mode is necessary, there is a different technique available. This idea came largely from New York Airways' flight testing of the Vertol helicopters, and specifically from New York Airways pilot Les Carter. The initial climb goes to critical height and then, at the point of engine failure, the pilot has the same choices as before. He can descend to the heliport, or he can dive slightly to accelerate to climb-out speed and still clear the 300-ft. obstacle at a distance of 2,400 ft.

It costs about 30 lb. of weight to seal the fuselage of the 107 during its fabrication, but that weight increase is far less than the weight of emergency flotation gear. This sealed fuselage gives primary buoyancy to the 107 in the event of a water landing, and the sponsons give additional buoyancy and lateral stability on the surface.

As far as the pilot is concerned, water approaches and landings are no different from those over land. He can flare to angles as high as 30 deg. if in autorotation. He can taxi on the surface, stop the rotors, start without initial swinging of the fuselage, and take off. If he cannot restart both engines, the 107 can be taxied on the surface for a running single-engine takeoff procedure.

Stability Augmentation

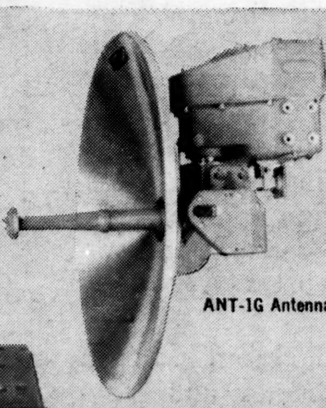
A unique feature of the Vertol helicopters is the stability augmentation system. This development gives the Vertol 107 dynamic stability about all three axes over the speed range from hover to maximum velocity.

It is, in effect, the inner loop of an autopilot system; it senses changes in attitude and feeds corrections into the flight control system at a point downstream of the pilots' controls. The pilots feel no motion of the stick, and they

"Wouldn't be without Bendix All-weather RADAR"

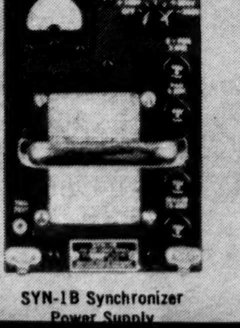
says Don Corey, Chief Pilot, Bundy Tubing Company

CON-1L-4 Control Unit

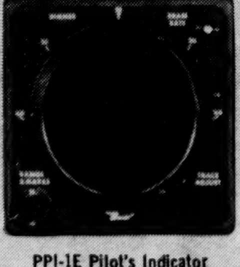


ANT-1G Antenna

RDR-1D Transmitter Receiver



SYN-1B Synchronizer Power Supply



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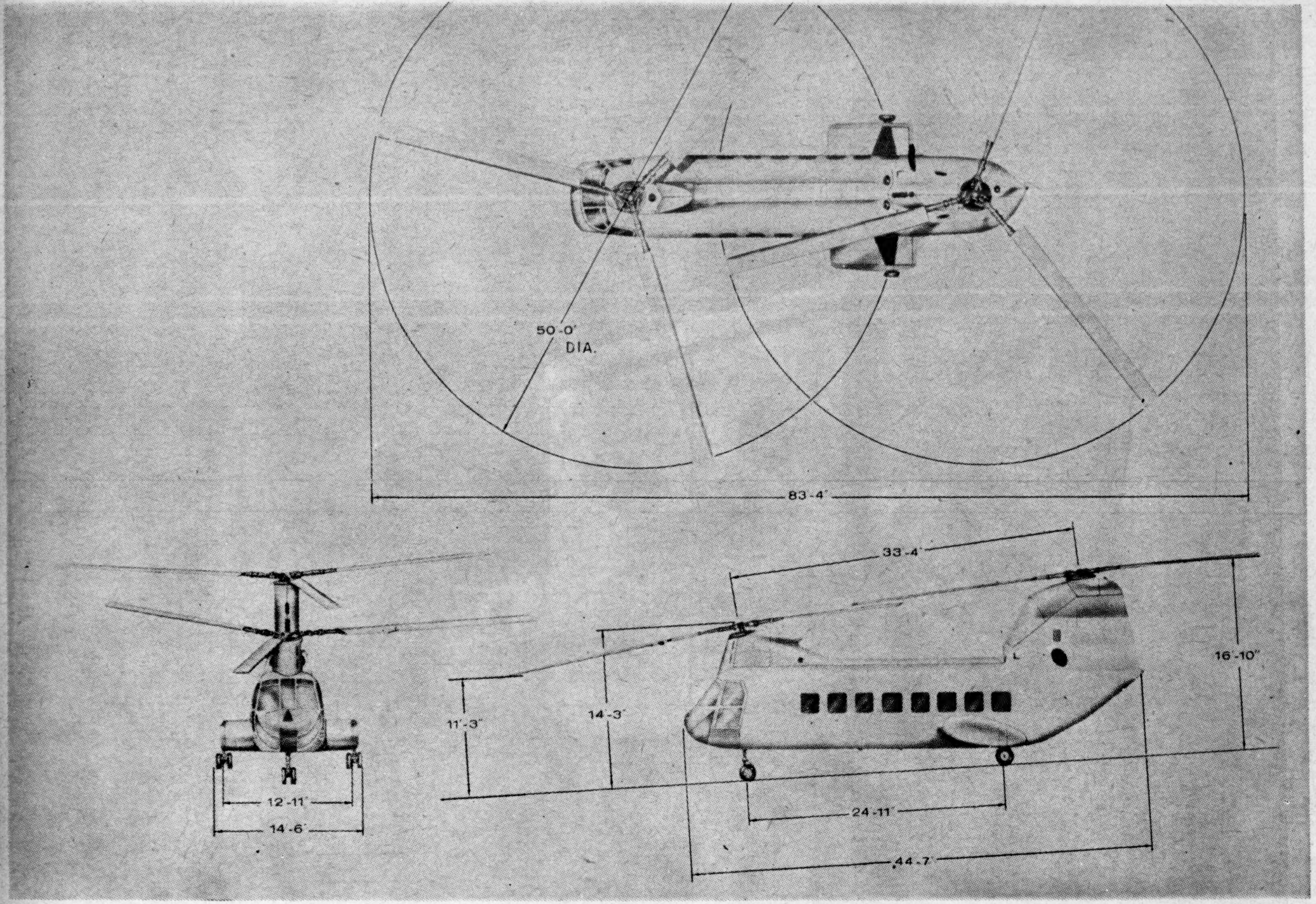


MODEL II Vertol 107 three-view shows the final configuration of the basic utility helicopter design.

have immediate and positive override of the stability augmentation system. For extra reliability, the system is made dual.

Pilots who have flown any of the Vertol helicopters equipped with stability augmentation—the prototype 107, the three YHC-1As and the five Vertol 44s delivered to the Germans—say that it gives the helicopter the equivalent of fixed-wing aircraft stability. The stability augmentation system will hold the helicopter point-stable in space for a period up to about five minutes in hovering, but then the aircraft begins to drift away from the point.

Autopilot Capability

If the customer wants full autopilot capabilities, the electronic components of automatic stabilization equipment can be added as the outer loop of the system. Vertol says this combination of dual stability augmentation and automatic stabilization equipment is lighter and less complicated than dual automatic stabilization equipment.

In addition to these two systems, a closer approach to an all-weather helicopter comes with the usual anti-icing provisions for windshield, engine inlet and guide vanes, and rotor blades.

Vertol began the process that led to development of the 107 with an 18-month market survey and design study in 1956-57. The aim of the survey was simple: find out what kind of a helicopter could best serve the maximum number of needs in the 1960s, assuming that gas turbine powerplants would then be available.

Framework was to include both military and civilian requirements; design criteria were to meet both applicable civil air regulations and military specifications.

The survey of the medium-helicopter market potential led to Vertol's decision to go ahead with design, construction and demonstration of a prototype with company funds. The final rough requirements for the design read like a list of idealized characteristics: multi-engine reliability, instrument flight rules capability, indiscriminate cargo and passenger loading for up to 30 people or their equivalent weight in freight. Engines were to be clear of the cabin; no passenger would have to sit above, under or next to a powerplant.

Fuel tanks were to be clear of the cabin laterally. Flotation capability and the ability to take off from water were specified. And, of course, all the operators wanted high cruising speed and low direct operating cost.

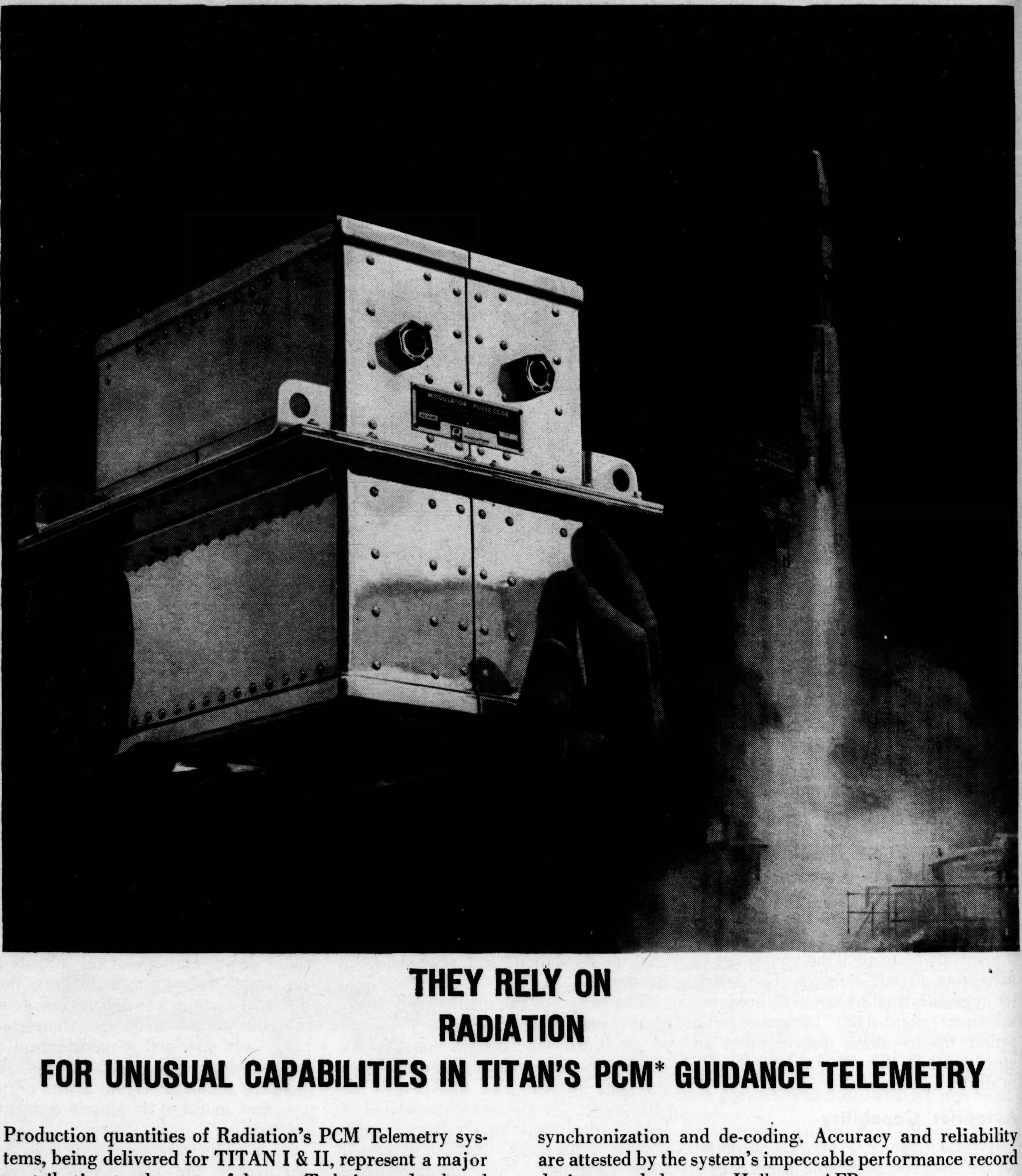
For reasons of familiarity and cost, one proven component was kept from the earlier Vertol helicopters: the rotor drive system from the Vertol H-21D. Engineers began drawing lines around this unit which was to be driven by a pair of 850-shp. Lycoming YT53-L-1 turboshaft engines bailed from the Army.

Design Changes

First flight of the prototype 107 was made Apr. 22, 1958. Following subsequent demonstrations of the aircraft to the Army's rotary-wing adherents, they ordered 10, enough to get the line going and production drawings completed. The Army specified a modification of the prototype, the YHC-1A, basically the same geometric layout as the prototype, but in detail an almost complete redesign.

None of the prototype parts were carried over to the YHC-1A design. Its powerplant became a pair of General Electric YT58-GE-6s rated at 900 shp. each.

Rating of the dynamic system was set at 1,700 hp. The rotor control system, which had been cables-and-pulleys, was changed to a push-rod system with actuators at the swashplates and pilot boost. Longitudinal cyclic rotor control had been specified on the prototype for pitch control, but this was dropped on the YHC-1A in favor of differential collective pitch change. Some longitudinal cyclic has been left on the rear rotor to handle trim changes with velocity in-



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crease. The speed increase is felt by a q-sensor (device for measuring dynamic pressure) which tilts the aft rotor forward as speed builds up.

The unsymmetrical flow pattern off the fuselage when the Vertol 107 is in forward flight produces a yawing moment. On the prototype this was compensated by a large bent tab, which looks like a conventional rudder, but on the YHC-1A, this offsetting moment was balanced by camber on the rear pylon. This makes it a vertical lifting airfoil, which produces the side force necessary to offset the disturbing yawing moment.

Somewhere well along through the design of the YHC-1As, Army selected another similar, but larger, Vertol helicopter—now to be designated the YHC-1B Chinook—instead of the YHC-1A types. The earlier order was cut back from 10 to 3 aircraft, and one section of Vertol's engineering department broke off to begin detailed design of the Chinook.

Even though it carries the same military designation, with only a different sub-type letter designation, the Chinook is a completely different helicopter from the other members of the Vertol 107 line.

With no prospects for a big military order in the offing, and no great hope of getting one, Vertol had the chance to take a second cold, analytical look at the 107's design.

"We were lucky in at least this one respect," said R. M. Degen, the company's assistant chief engineer. "We had two chances for redesign of a basic configuration. We could pick up all the complaints and do something about them."

The prototype had been just that kind of an aircraft, built to prove a principle and provide a demonstrator. The YHC-1A had been an Army aircraft straight through. Now the Vertol engineers wanted to try a different approach; they determined that the 107 Model II would be an all-purpose type. The plan was to build a basic flying machine which could—with the addition of extra equipment packages—be modified to perform a variety of tasks.

Under this scheme, production lines would turn out identical machines, regardless of the ultimate customer. One buyer might add communications and navigation equipment, seats and interiors, and have a short-haul transport. Another might leave the fuselage bare, install provisions for a cargo sling and then be ready to go logging.

It was this basic concept of a versatile, functional helicopter with "customized" extras that led to the name of the "mission module" helicopter.

Degen said it required about 150,000 engineering man-hours to take the Vertol design from the YHC-1A to the Model II layout. This included meeting the requirements of the then-new FAA, Vertol's product-improvement program, and development of the modular concept.

Vertol 107 Performance

Weights, performance figures and direct operating costs for the Vertol 107 Model II vary with configuration, operator, mission and a variety of other factors. But a typical utility configuration powered by T58-GE-8 engines weighs 18,450 lb. gross, 9,298 lb. empty, and will lift a 9,152-lb. useful load, almost half of its total weight.

This same helicopter will have a maximum forward speed of 141 kt. and a cruise speed for best range of 130 kt.

Its vertical rate of climb, limited by transmission capacity of 2,300 shp., will be 1,240 fpm. Its hovering ceiling, out of ground effect on a 95 F day, will be 800 ft. with military power on both engines.

Mission considered here is warmup, climb to 5,000 ft., cruise out with payload for 100 naut. mi. at best range speed and land with 10% initial fuel in reserve.

There was no redesign of the YHC-1A necessary but, said Degen, "major changes" were made. More growth was designed into the dynamic system to account for the expected power growth of the T58. Production engines—T58-GE-8 powerplants rated at 1,250 shp. each—were installed. Rotor diameter was increased by 2 ft. to 50 ft., and the dynamic system was rated at 2,300 shp.

Further changes in the control system saw a move to a complete, dual powered flight-control arrangement. Provision was made for substitution of the de Havilland Gnome H.1200 engine—equivalent to the General Electric CT58-110-1 engines which will power commercial versions of the Model II—to make the helicopter attractive to prospective foreign purchasers in sterling-bloc countries.

The problem of building prototype Model II aircraft was solved when the Army, which had wanted to sponsor the program heavily all alone but had been unable to do so because of the economics of production lines, bailed two of the YHC-1A aircraft back to Vertol for modification to Model II standards and certification flight tests. This in one way took away some of the sting when Army cut back its original order for 10 YHC-1As to three.

This is not the end of the line for the Vertol 107, according to the company's engineers. Lee Douglas, Vertol director of engineering, delineated a development program aimed at an advanced configuration designated Model VI, which is now in the preliminary design and wind-tunnel testing stages.

Major aim of the design is increased speed, and most of the effort is going toward drag reduction of the major factors which fight speed. Advanced General Electric T58 engines, each rated at 1,400 shp., will be installed, and the dynamic system will be uprated again.

Rotor blade lift coefficient will be reduced by dropping the thickness ratio of the airfoil; this will improve critical Mach number somewhat, permitting higher tip speed in turn. Blade chord will also be increased to maintain total lift of the rotor.

Other drag reduction items include retracting the landing gear, extending the fuselage aft section and adding rotor hub fairings. Cruise speed is expected to improve from the 138-kt. value of the Model II to 176 kt. of the Model VI. Payload will remain constant, but direct operating cost will decrease somewhat.

This apparently is not the end of the line, either. Douglas said that the pure helicopter continues to look good up to about 200 kt., based on foreseeable technology. But major leaps could still occur and raise the possible top speeds even higher.

Whether or not this will happen is a matter for engineering conjecture. Both the VTOL aircraft and the compounded helicopter show promise at the high-speed end of this speed scale, and Vertol, with much interest in both these types, may swing more heavily to one or both to satisfy the proponents of high-speed flight coupled with a vertical mode.

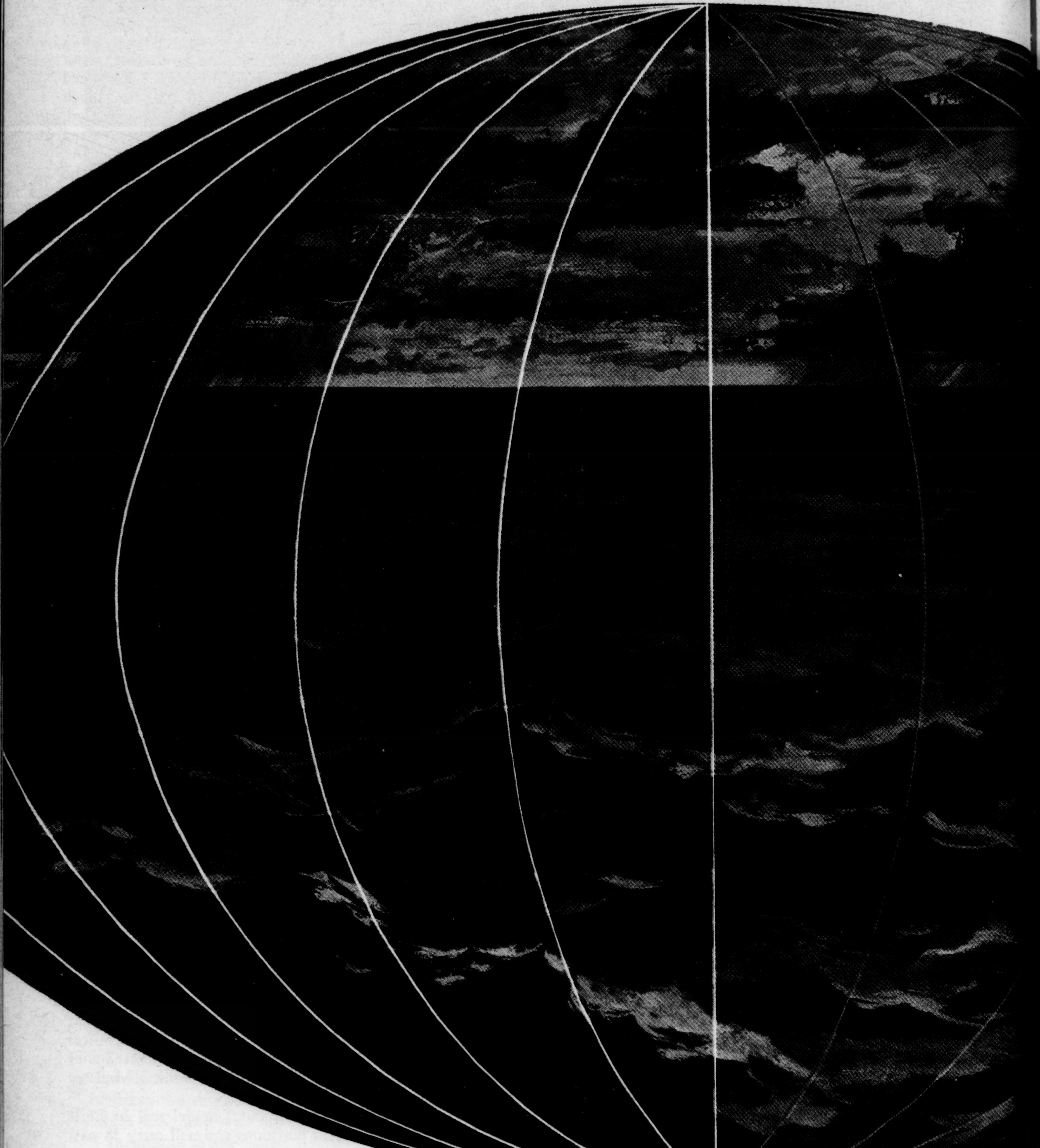
Right now the 107 has been ordered as a civil transport and as an assault transport. Developments of the type are being sponsored, and the Vertol management is betting that for this five-year-old, life has just begun.

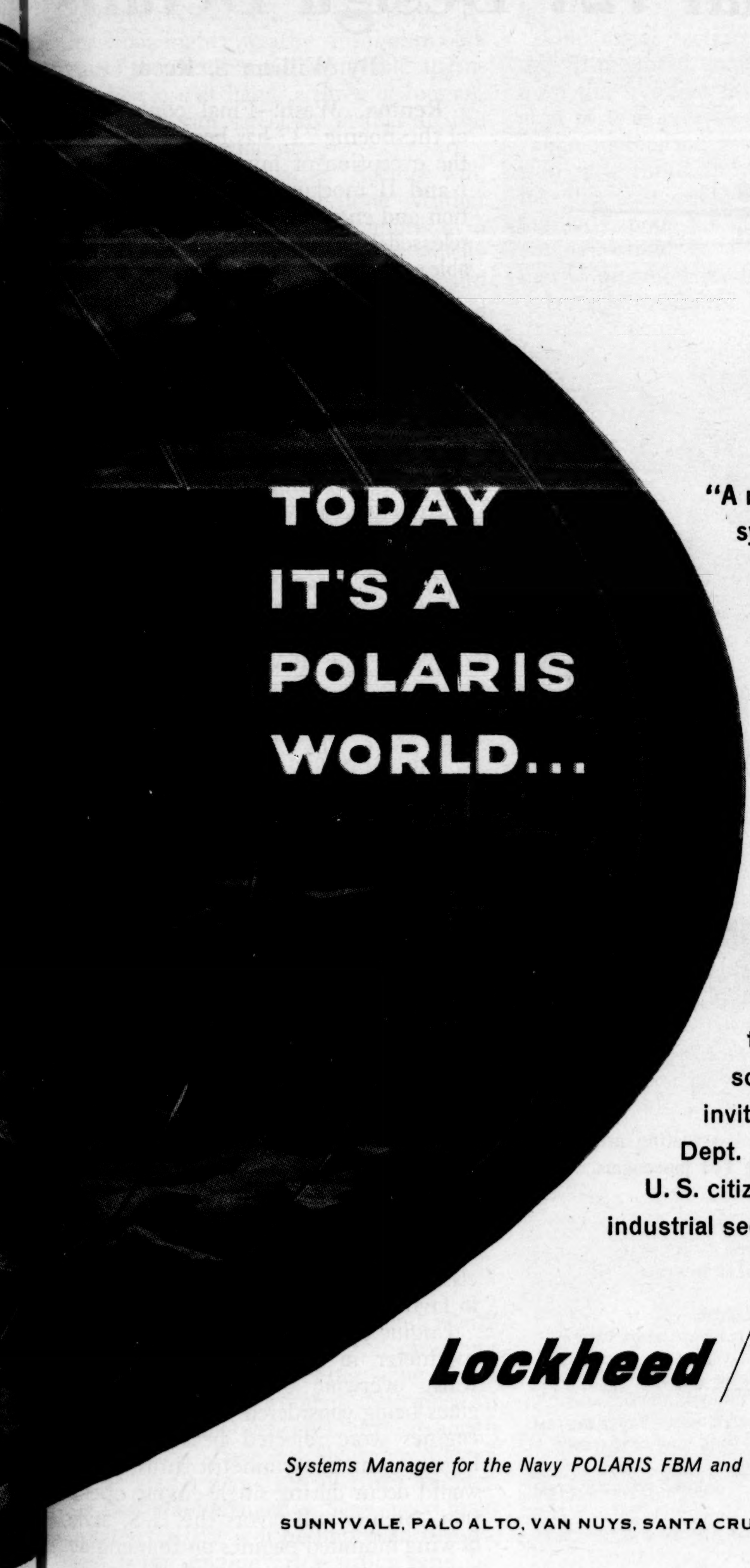
Soviets Are Developing Air-Cushion River Boat

Moscow—Flying river boat using the air cushion principle is reported under development by the Central Technical Design Bureau of the Russian Soviet Federated Socialist Republic's Ministry of the River Fleet.

An experimental model will be built on twin pontoons and will carry 38 passengers and have a 34-mph. maximum speed, according to Pravda. Lift will be provided by two aircraft engines. A third engine mounted behind the cabin will propel the craft, which will be maneuvered by an aircraft-type rudder on the stern.

The Soviet Union is developing the craft to travel smaller and shallower streams than the hydrofoil, which also is under development by the Ministry of the River Fleet.





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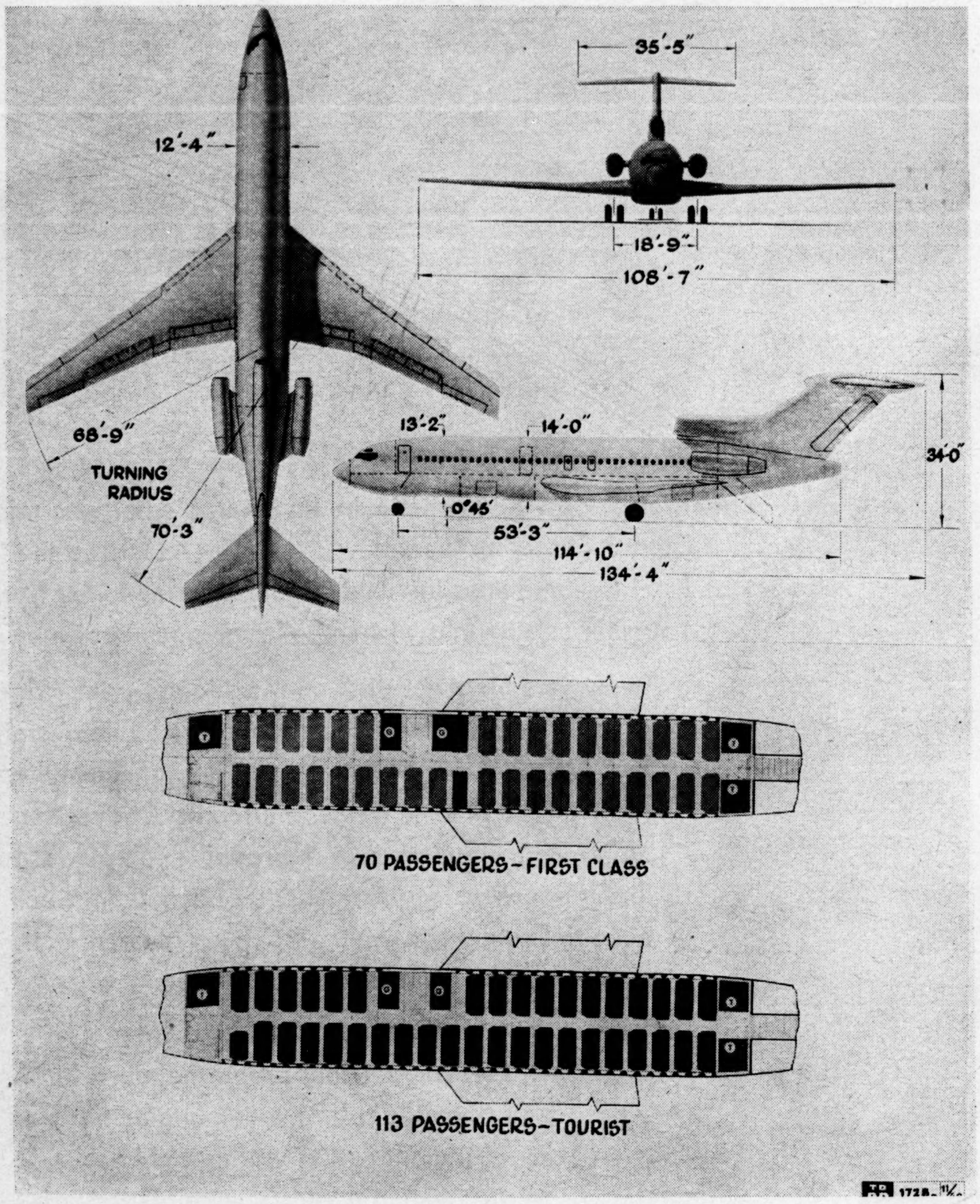
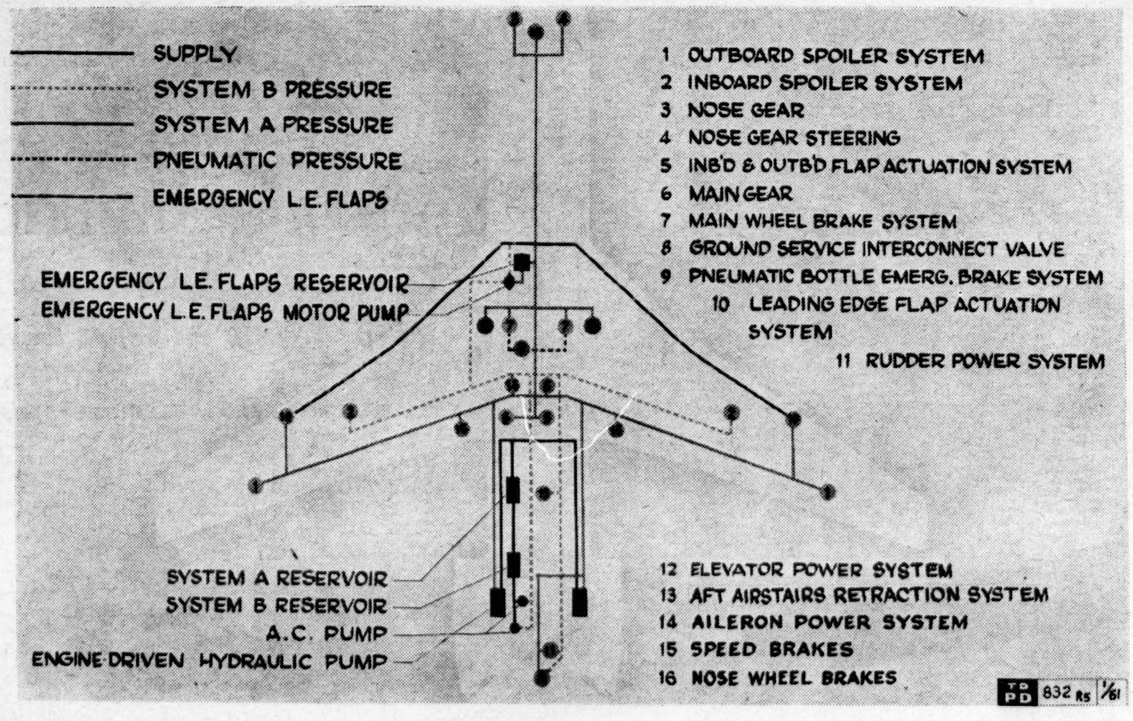
Boeing Reveals Final 727 Design Details


35'-5"
12'-4"
18'-9"
108'-7"
13'-2"
14'-0"
34'-0"
68'-9"
TURNING RADIUS
70'-3"
0°45'
53'-3"
114'-10"
134'-4"
1728

70 PASSENGERS–FIRST CLASS

113 PASSENGERS–TOURIST

THREE-VIEW above shows final configuration of 727. All-first-class seating arrangement will accommodate 70 passengers; all-tourist configuration will seat 113 passengers.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SYSTEM A PRESSURE
PNEUMATIC PRESSURE
EMERGENCY L.E. FLAPS
1 OUTBOARD SPOILER SYSTEM
2 INBOARD SPOILER SYSTEM
3 NOSE GEAR
4 NOSE GEAR STEERING
5 INB'D & OUTB'D FLAP ACTUATION SYSTEM
6 MAIN GEAR
7 MAIN WHEEL BRAKE SYSTEM
8 GROUND SERVICE INTERCONNECT VALVE
9 PNEUMATIC BOTTLE EMERG. BRAKE SYSTEM
10 LEADING EDGE FLAP ACTUATION SYSTEM
11 RUDDER POWER SYSTEM
EMERGENCY L.E. FLAPS RESERVOIR
EMERGENCY L.E. FLAPS MOTOR PUMP
SYSTEM A RESERVOIR
SYSTEM B RESERVOIR
A.C. PUMP
ENGINE-DRIVEN HYDRAULIC PUMP
12 ELEVATOR POWER SYSTEM
13 AFT AIRSTAIRS RETRACTION SYSTEM
14 AILERON POWER SYSTEM
15 SPEED BRAKES
16 NOSE WHEEL BRAKES
832

HYDRAULIC system of Boeing 727 is shown above. Dual system is used to power the elevator, rudder, ailerons and spoilers. In event of complete hydraulic failure, system reverts automatically to a mechanical backup.

By William S. Reed

Renton, Wash.—Final configuration of the Boeing 727 has been frozen with the exception of minor changes. Class I and II mockups are nearing completion and engineering drawings are being released to shops as they become available.

Present production schedule calls for the first metal to be cut in about three months with roll-out of the first prototype in September, 1962. Initial flight is scheduled for November, 1962 and the first customer delivery will be in the fall of 1963.

Internal decision to go ahead with the design was made last August and announced publicly following receipt of orders from United Air Lines and Eastern Air Lines (AW Dec. 12, p. 40).

Design of the 727 was dictated by the existing competitive domestic route structure and by the fact that present four-engine jet transports must operate at high load factors to reach a breakeven point. The 727, according to John F. Steiner, chief project engineer, will operate over route segments as short as 265 mi. with a breakeven load factor of about 65%. For longer stages, the load factor sinks considerably lower—45% on 600-mi. lengths and 35% on 1,000-mi. segments.

Direct operating cost of a fleet of 50 727s, Steiner says, will be $30.5 million less than a fleet of the same number of Boeing 720Bs during the service life of the equipment.

Boeing nearly got the go-ahead on a twin-jet version of a short-medium-range jet dubbed the 720 Jr., and numerous designs were considered before the present version was selected. Initially, a four-engine version, powered with engines in the 6,000-lb.-thrust class, was considered, but was rejected in favor of a twin-engine model.

Engine placement became the critical parameter in the design with underwing, overwing and aft-mounted engines being considered. Wing mounted engines were rejected because of the large amount of asymmetric thrust which would occur during single-engine operation. Steiner still favors the U.S. style of wing mounted engines on four-engine aircraft primarily because of the relieving of upward bending loads in flight offered by the outboard pods. This enabled a lighter structure to be designed, a feature not so important in twin-engine craft because of the proximity of engines to the fuselage. Overwing mounted engines lost out because of flutter problems which showed up during wind tunnel testing.

The twin-engine configuration lost

out, Steiner points out, because of the airlines' desire for greater all-weather capability. Twin-engine transports suffer from higher weather minimums because they require that a suitable alternate be close at hand; a three or four-engine craft can safely fly farther in the event of engine failure.

The Federal Aviation Agency will, Boeing says, apply the same weather minimums to a 727 that apply to a four-engine transport because it will fly to a destination on two engines and maintain flight on one engine below a certain weight and altitude.

Steiner says consideration was given to aft-mounting four engines after the fashion of the Vickers VC. 10 but that this was rejected because Boeing does not consider this a true four-engine aircraft. Clustering the engines together in one pod leads to the possibility of explosive failure in one engine causing damage to the other. Steiner says that statistics of B-47 and B-52 types show that compressor failures in particular can cause damage to adjacent engines in clustered pods.

The problem of engine placement still was not solved by the decision to go to a three-engine configuration, however, and Boeing briefly considered a design with two underwing pods and one tail-mounted engine. This created many problems caused by the engines being so widely separated.

Tail-Mounted Engines

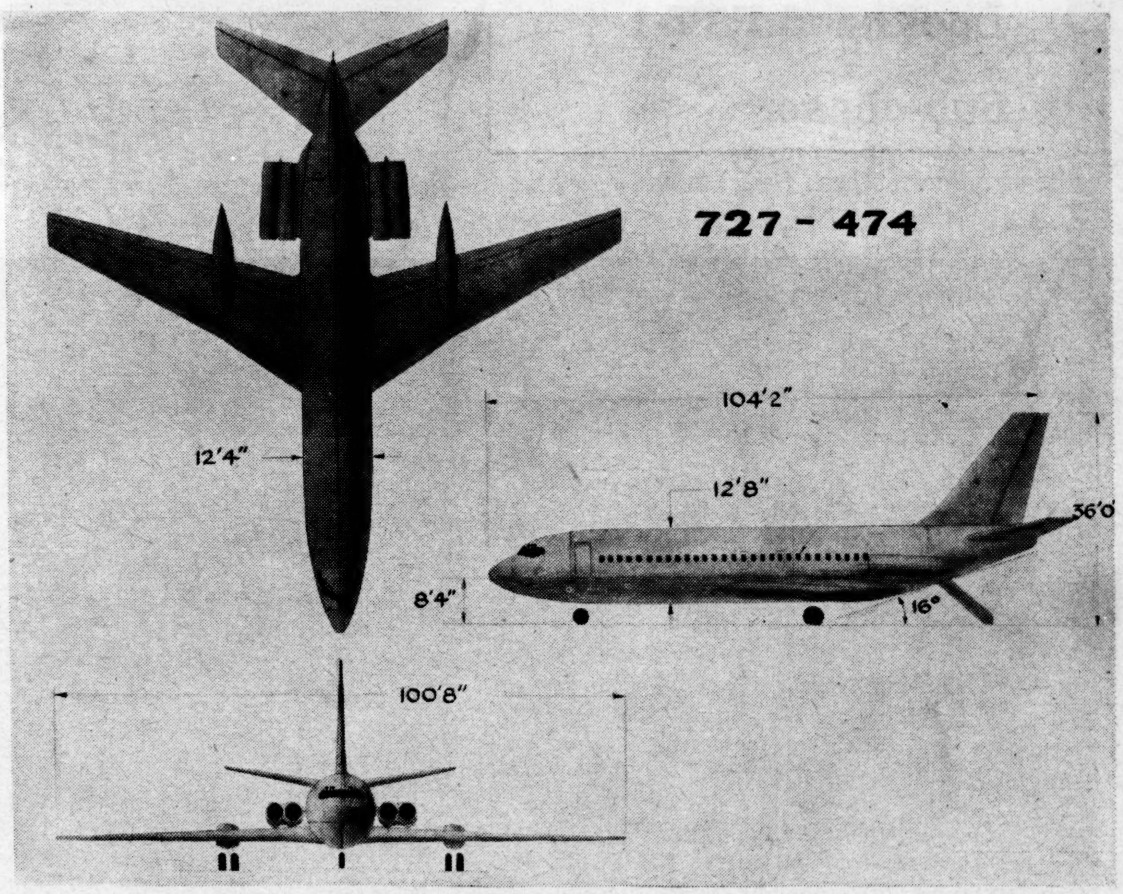
The 727 configuration, with three tail-mounted engines instead of two in wing pods, became the final choice despite Boeing's long favoring of pod-mounted engines because of these factors:

- **Climb weight** during second takeoff segment will be increased by 3,000 to 5,000 lb. Engine failure in a three-engine craft will be less serious than in a twin and close mounting of the engines will produce less asymmetric thrust, hence less trim drag.
- **Lower body.** Absence of underslung pods will permit a lower gear providing for reduced weight, better wing access and passenger movement. Sacrificed in this case is engine accessibility, although the 727 will have quickly removable engine access doors for all three engines.
- **Better aerodynamics.** Slow speed flight characteristics will be improved because of better engine inlet airflow and because of the absence of flap cutouts for the exhaust of underwing engines. Center engine inlet will be the most critical but Steiner believes that duct problems are solved by the design. The 727 models in the wind tunnel have shown adverse flow characteristics at the side engine inlets at very high angles of attack but this comes usually after the stall angle is reached.
- **Advantages will include** a quieter cabin, less tail-tip tendency and higher inlets to minimize foreign object damage.

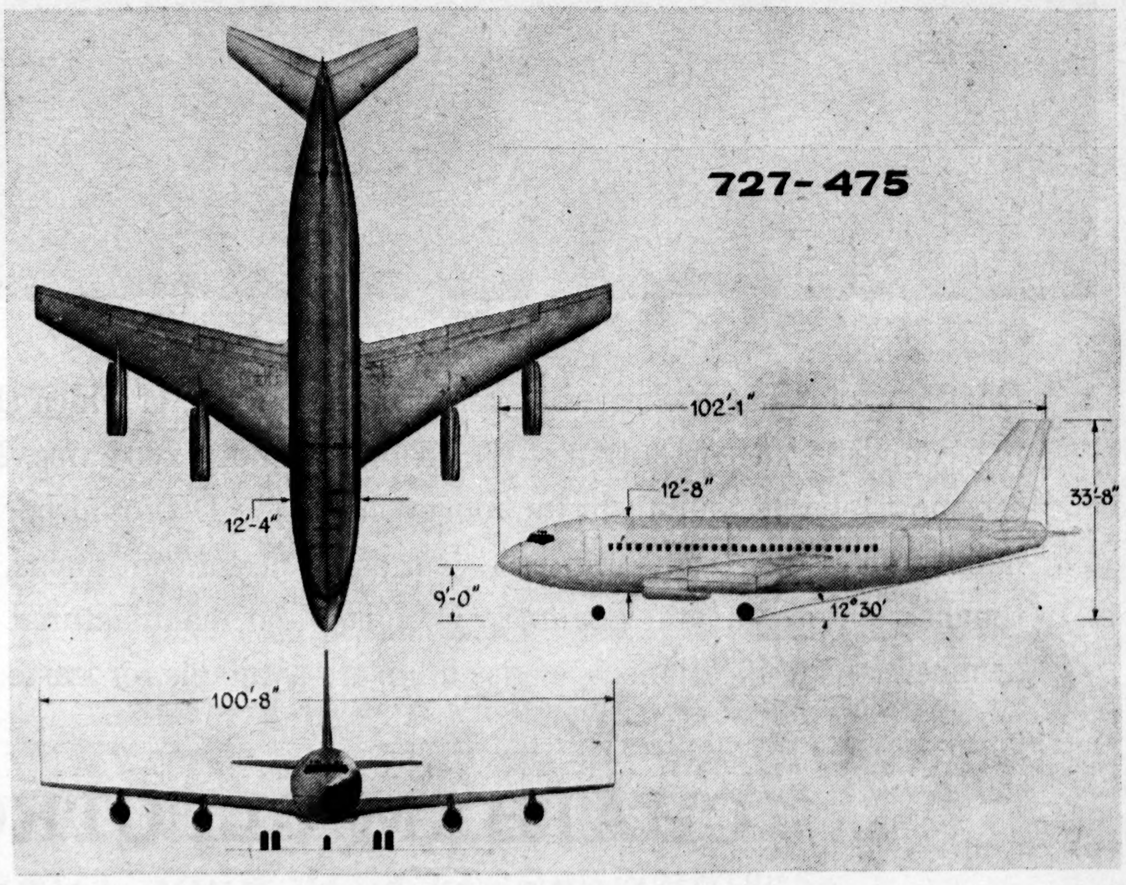
One major sacrifice made in choosing aft-mounted engines is a departure from the trend of using as many common parts as possible with the 707 and 720 models. Had the underslung pods won out, those already in production for the 720 could have been used. Similarly, pods for both left and right engines would have been identical as in the present aircraft.

Interchangeability is stressed in the 727 design and becomes pronounced in the fuselage. The entire cabin from the aft pressure bulkhead forward and from the floor upward will be identical to that of the 720. Fuselage nose from the entrance door forward and the flight deck will be identical. General arrangement of instrument panel and flight controls will in all respects be the same, making for a minimum of transition time for pilots from one aircraft to the other.

Wing on the 727 will be a one-piece assembly through the fuselage, with re-



AFT-MOUNTING four engines as in Vickers VC.10 was considered, but clustered engine concept rejected because of possibility of explosive failure in one engine damaging the other.



WING-MOUNTED engines, as shown in four-engine configuration above, were rejected because of asymmetric thrust which would occur during engine-out operation.

CHATHAM Y-SERIES TRANSFORMER RECTIFIERS

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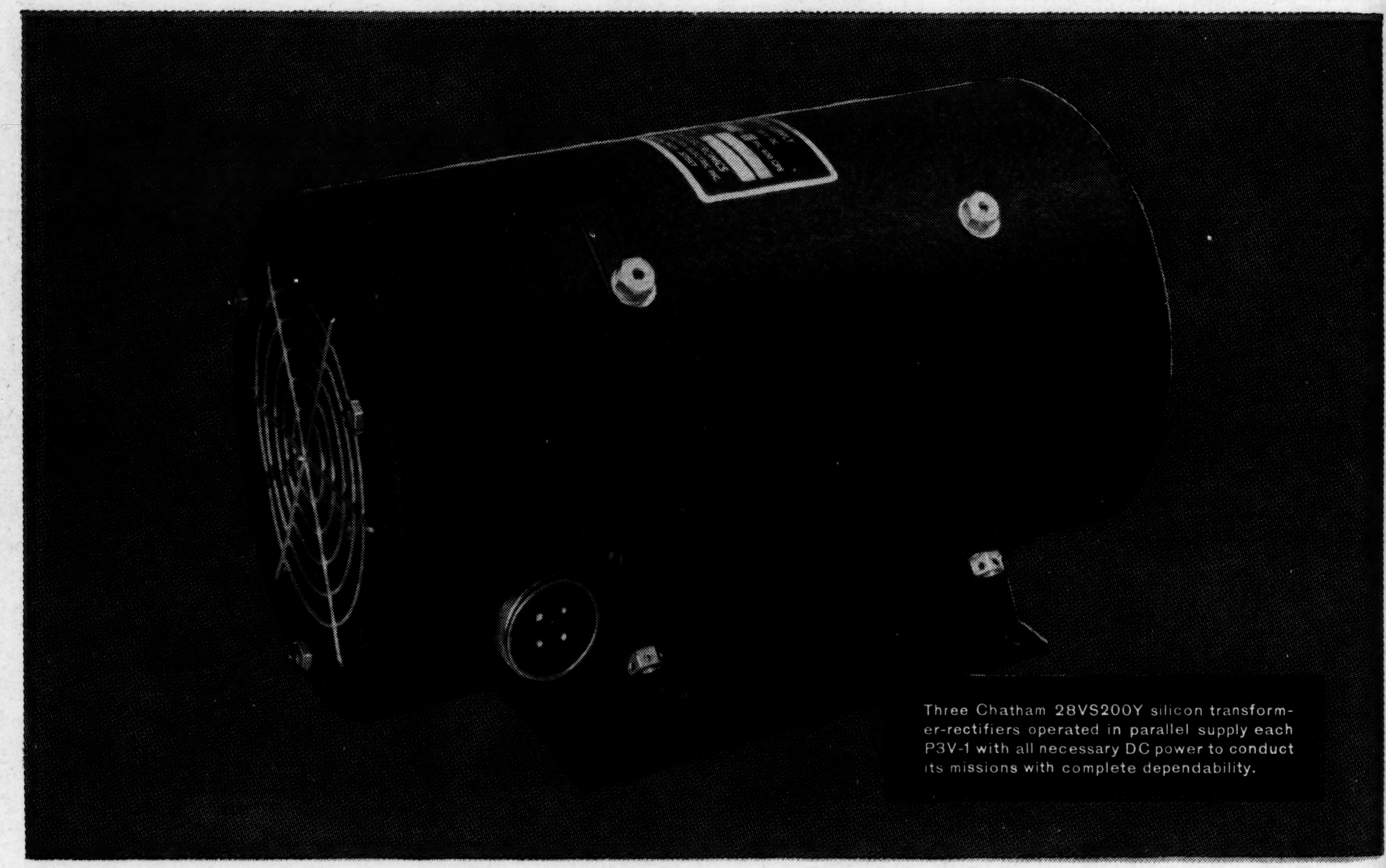
The prop-jet P3V-1 is U.S. Navy's newest anti-submarine warfare patrol airplane. Equipped with special electronic gear to find and localize submerged metallic targets, the P3V-1 can home in and attack with its large store of kill weapons.



Three Chatham 28VS200Y silicon transformer-rectifiers operated in parallel supply each P3V-1 with all necessary DC power to conduct its missions with complete dependability.

Chatham's famous Y-Series of transformer-rectifiers, of which the 28VS200Y is one, is available in a complete range of outputs from 20 amps through 200 amps. The Y-Series represents the lightest, most reliable equipment for converting AC to DC for airborne or ground applications. Chatham's famous written guarantee is your assurance of continuous, trouble-free operation under the toughest environmental extremes. Designed and manufactured to a wide range of military and commercial specifications, Y-Series units are available for immediate shipment.

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movable tips. Primary structure will be of aluminum alloy skin stiffened by stringers. Spars will carry shear loads while skin and stiffeners support most of the bending loads.

Landing gear will be designed for 60,000 landings with replaceable components designed for a minimum of 5,000 landings. The addition of nose wheel braking will cut 7 to 14% from the landing roll. Anti-skid braking will be incorporated.

Side engines will be mounted in pod-type nacelles attached to the main fuselage structure. The center engine will be mounted below the main structure on a strut with its cowling forming the lower rear fuselage contour. Drain traps will be incorporated in the lower engine fairings so that passengers entering through the rear entrance stairway will not be subjected to oil or fuel dripping.

Control System

Possibility of control system damage through failure of the center or either of the side engines is minimized by utilizing heavy structural members as shields and by routing dual hydraulic and electrical lines at points remote from each other. With this arrangement, a catastrophic engine failure such as a compressor failure will not be likely to sever both sets of hydraulic lines.

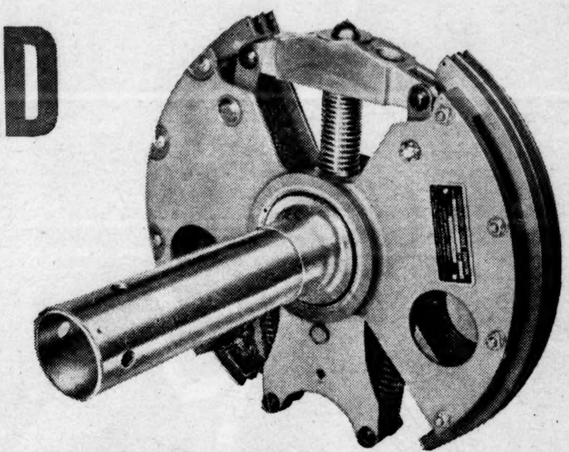
Horizontal stabilizer is placed high to avoid flow disturbances from the flaps at low speed. The stabilizer is movable for trim while the elevator provides for longitudinal maneuvering. A dual hydraulic system is used to power the elevator as well as the rest of the control surfaces, including the rudder and the ailerons and spoilers.

Separate systems are employed operating in tandem and powered by engine-driven pumps on each of the side engines, backed up by electrically-driven hydraulic pumps. In the event of complete loss of hydraulic power, the system reverts automatically to a mechanical backup. Control force feel is artificially supplied when operating on the irreversible hydraulic system.

Handling qualities of the 727 have been under investigation for some time through the use of an analog computer flight simulator. Limited in scope, the computer, together with a rather simplified cockpit mockup, is used to explore the effects of different gross weights, flap configurations, etc., during approach and landing before a more thorough analysis is made. Aerodynamic equations, linear in nature, are handled by components in a bank of eight computers while non-linear equations such as a drag polar, are handled by function generators. Variable lift and drag coefficients can be set in the computer's amplifiers by the use of potentiometers.

Starting usually at an altitude of

CABLE CONTROL SENSITIVITY
ASSURED



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They provide steady and uniform control response—instant compensation for thermal and/or mechanical variations and dependable performance under all flying conditions.

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Models are available, or can be developed to meet any cable control system need.

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PROBLEMATICAL RECREATIONS 56

Three farmers rented a pasture for a fixed amount, each to pay in proportion to the stock pastured. First month, A put in 3 horses and B and C each some horses, B paid $6, A and C defaulted payment. Next month, each put in one more horse, C paid $7.20, A and B defaulted payment. Next month, each put in one more horse, A paid $5, B and C defaulted. Required: (1) rent of pasture per month; (2) number of horses B and C each put in during first month; (3) amounts A, B, and C owed for unpaid service. —*American Mathematical Monthly*

If you're getting your physiological signals crossed—either mental or muscular – investigate a new B-30ATP Bio-pack, a product of our Litton Systems Division. First in a series of miniaturized instruments for medical electronics, the Bio-pack amplifies and transmits all bio-electric signals from the micro-volt to the millivolt range. The unit is now in operation at universities, space labs, and medical centers. Interested? Signal us at our Computer Systems Laboratory, 5500 Canoga Ave., Woodland Hills, Calif.

ANSWER TO LAST WEEK'S PROBLEM: There are 21 edges. A famous formula of Euler says vertices − edges + faces = 2, for any solid figure with no holes, so that the number of faces is 14.

LITTON INDUSTRIES
Beverly Hills, California

Five units comprise the Bendix repeater to relay messages in the UHF band between ground stations and aircraft.

THE FIRST UHF REAL-TIME ACTIVE SATELLITE REPEATER, designed for one year of continuous operation in orbit, has been developed and fabricated by Bendix Systems Division under sponsorship by the Wright Air Development Division of the United States Air Force in conjunction with an ARPA program. This development typifies programs offering new career opportunities to better engineers and scientists.

BENDIX SYSTEMS DIVISION
ANN ARBOR, MICHIGAN

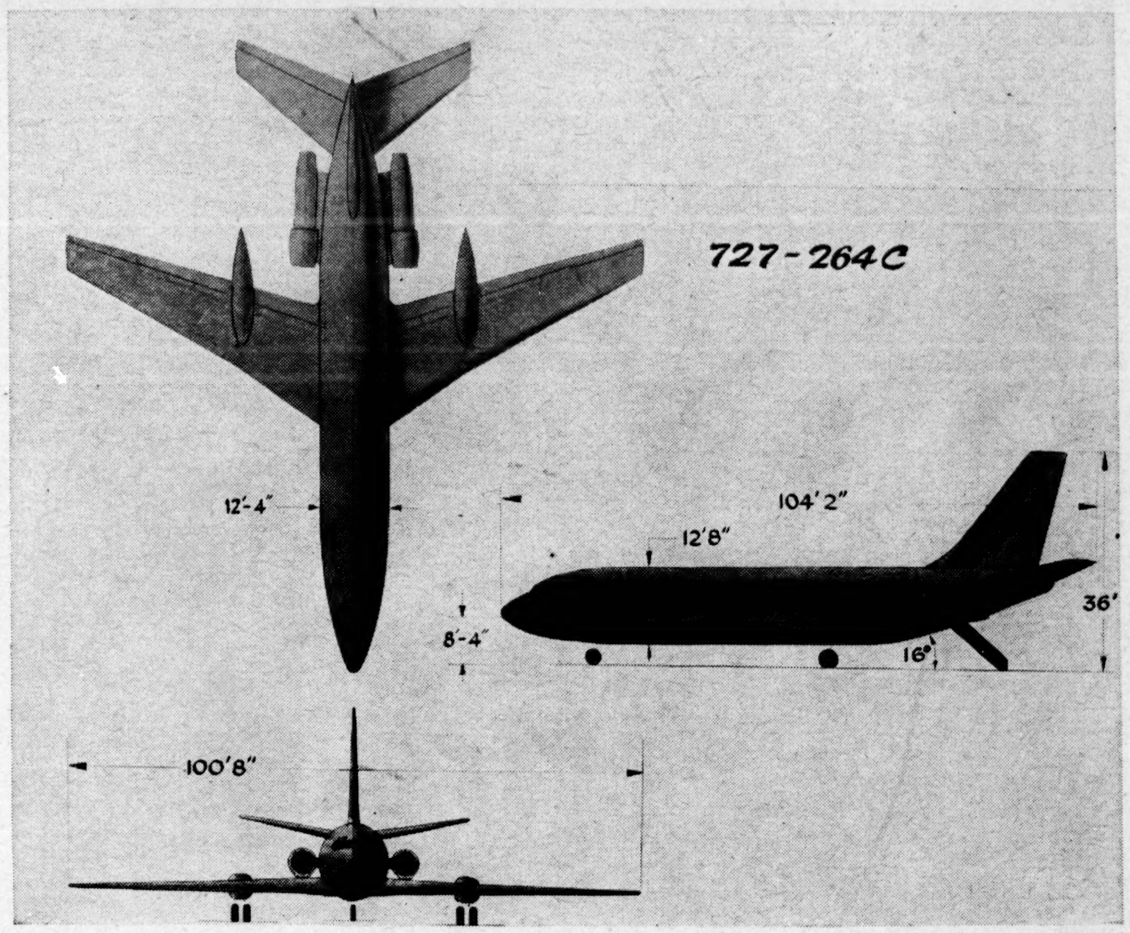
THE Bendix CORPORATION

1,500 ft., and from a distance of 40,000 ft. from touchdown, the computer displays aircraft position and altitude on a 17-in. oscilloscope as a result of integrating the inputs of known variables and variables added by control system inputs from the pilot.

Frequently, evaluations of problems submitted to the computer group by wind tunnel personnel or other aerodynamicists can be handled by computer personnel. However, Boeing pilots frequently are called in to operate the simulator when a particular set of conditions look promising and handling quality comments are required.

Wing flaps are of the triple-slotted type to produce high lift coefficients at low speed. Full-span leading edge devices consist of retractable slats outboard and Krueger flaps inboard.

Approach speed of the 727 is expected to be 110 kt. with stall occurring at 86 kt. Wing is designed to stall at a point about 15 ft. out from the fuselage rather than at the root, as is normal. This will permit flying in a partial stall without causing the disturbed air generated to be introduced into the side engine inlets.



CARAVELLE-type twin-engine configuration was discarded by Boeing because of airlines' desire for greater all-weather capability for the 727.

Performance of the 727 will be tailored to the short-haul market with rapid rates of climb and descent. Climb performance will enable the aircraft to reach 25,000 ft. in 10 min. and the cruising speed of the aircraft will be slightly under 600 mph. Speed placards above 10,000 ft. will read Mach .88 or an equivalent airspeed of 450 mph. Standard day cruise at Mach .85 or .86 at 25,000 ft. would yield a cruising true airspeed of 585 to 595 mph. This is possibly the area at which Boeing is aiming.

Boeing 727 Data

	Dimensions
Wing span	108 ft. 7 in.
Over-all length	132 ft. 5 in.
Elevator span	35 ft. 5 in.
Wing area	1,650 sq. ft.
Over-all height	34 ft.
Fuselage length	114 ft. 10 in.
Fuselage width	12 ft. 5 in.
Fuselage depth	13 ft. 2 in. forward 14 ft. aft
Landing gear tread	18 ft. 9 in.
Wheel base	53 ft. 3 in.
Turning radius	70 ft. 3 in.
	Weights
Maximum takeoff gross	142,000 lb.
Maximum landing weight	131,000 lb.
Zero fuel weight	109,000 lb.
Operating weight, empty	81,000 lb.
Weight, empty	77,500 lb.
Payload	24,000 lb.
	Capacities
Passengers, first class	70
Passengers, mixed	94
Passengers, all tourist	113
Cargo volume	400 cu. ft. forward 450 cu. ft. aft
Maximum fuel	7,000 U. S. gal.

Range of the 727 will be in excess of 1,700 mi. although it is designed primarily to operate over ranges considerably less.

Direct operating cost estimated by Boeing over a 400 mi. stage is $1.55/mi., over a 600 mi. route it is $1.40/mi. and below $1.30/mi. for ranges beyond 1,000 mi. Cost per seat mile in coach configuration is 1.4 cents a mile at 400 mi., 1.25 cents a mile at 600 mi., and 1.15 cents a mile at 1,000 mi.

Interior dimensions of the 727 passenger cabin will be the same in diameter as the present Boeing 707/720 cabins, permitting either 4, 5, or 6-abreast seating. The same hardware and other interior furnishings presently developed for the 707/720 aircraft will be used, providing a saving in production costs. Items such as seats, windows, cabin panels, lights, etc., will be interchangeable with stocks already in existence.

Pressurization and heating of the cabin will be accomplished with units identical with or very similar in design to those already in use on present Boeing equipment. An 8.6-psi. differential can be maintained in the cabin, affording sea level pressure up to 22,500 ft. Full heating and pressurization can be maintained with any two of the three engines operating.

Fuel for all three engines will be carried in the wings of the aircraft in accordance with standard practice. Each engine will have its own fuel supply, although the standard provisions of crossfeed, whereby any engine may feed off any tank, will be incorporated. Fuselage fuel is not planned for the 727 although Boeing engineers predict that the demands of ever-increasing range eventually will force a trend in this direction.

Production of the new tri-jet will be phased into the same production line now being used for the 707 models, the 720 and the C-135s. Plans are that production of all three types in various models will be concurrent. Three aircraft will be built for the test program, none of which will be retained as a prototype as is the present dash 80 aircraft.

Rate of production at Renton now stands at 80 aircraft per month, down from a high of 90 per month at the end of last year. Figures include 707, 720, 727 and KC-135 aircraft. Tooling for the 727 will cause the rate to drop to below 60 at the end of 1963, then climbing to 100 aircraft per month by the end of 1964.

Pratt & Whitney JT8D-1

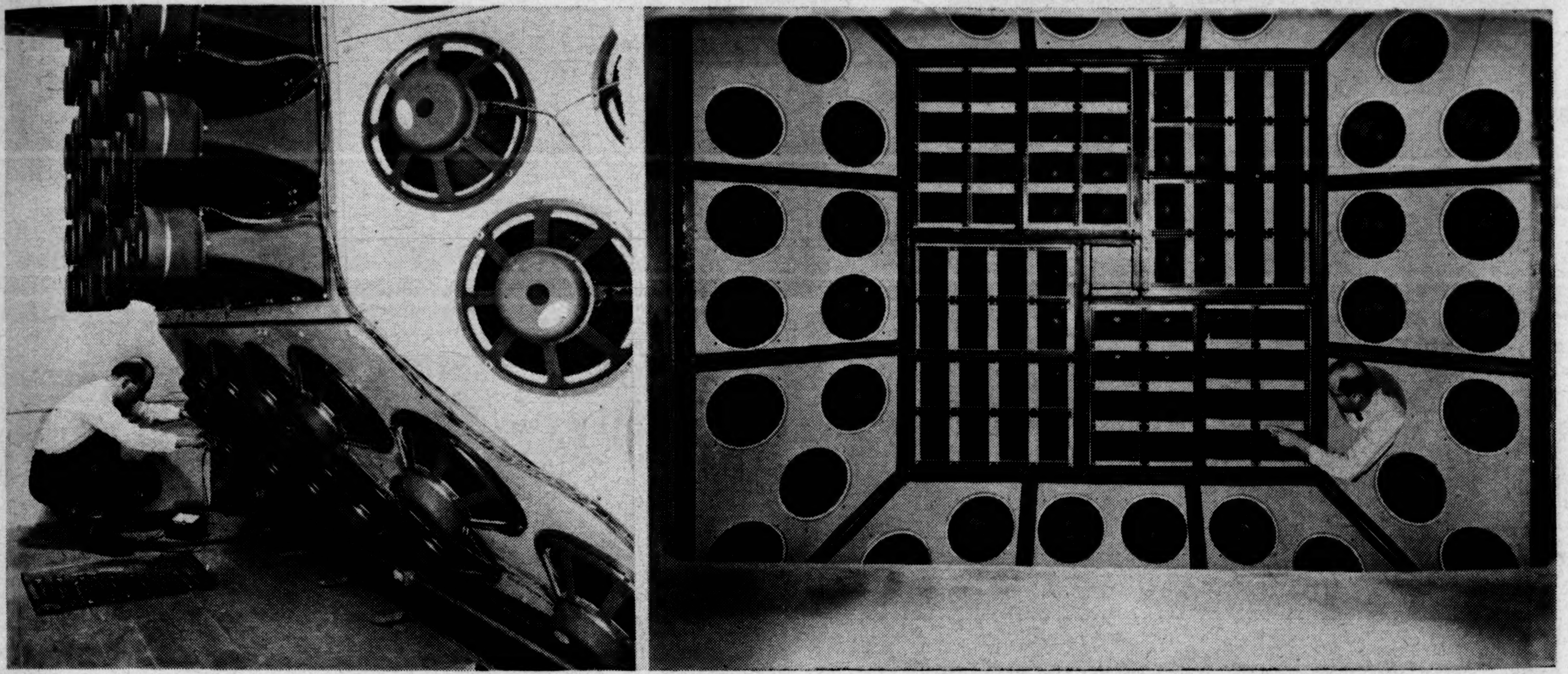
Sea-level thrust	14,000 lb.
Basic weight	2,980 lb.
Thrust-to-weight ratio	4.7 to 1
Specific fuel consumption (35,000 ft. at Mach .89)	812 lb./hr./lb.-thrust

Individually-controlled thrust reversers on all three engines. At least 50% of forward thrust available for reverse thrust.

SPERRY

A highly sophisticated long range tracking and acquisition radar has been designed and fully developed by Sperry. The advanced capabilities of this new shipboard design provide the breakthrough in instrumentation radar required for advanced missile and space programs. While its performance parameters will not be discussed here, qualified persons are invited to communicate directly with the Marketing Manager of the Division.

SURFACE ARMAMENT DIVISION, *SPERRY GYROSCOPE COMPANY, DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, N. Y.*



ONE OF 112 speakers in Goodyear's acoustical chamber is checked at left. Right photo shows 64 mid-range speakers surrounded by 48 bass speakers. Chamber is used to simulate environment which missile and aircraft components would experience in flight.

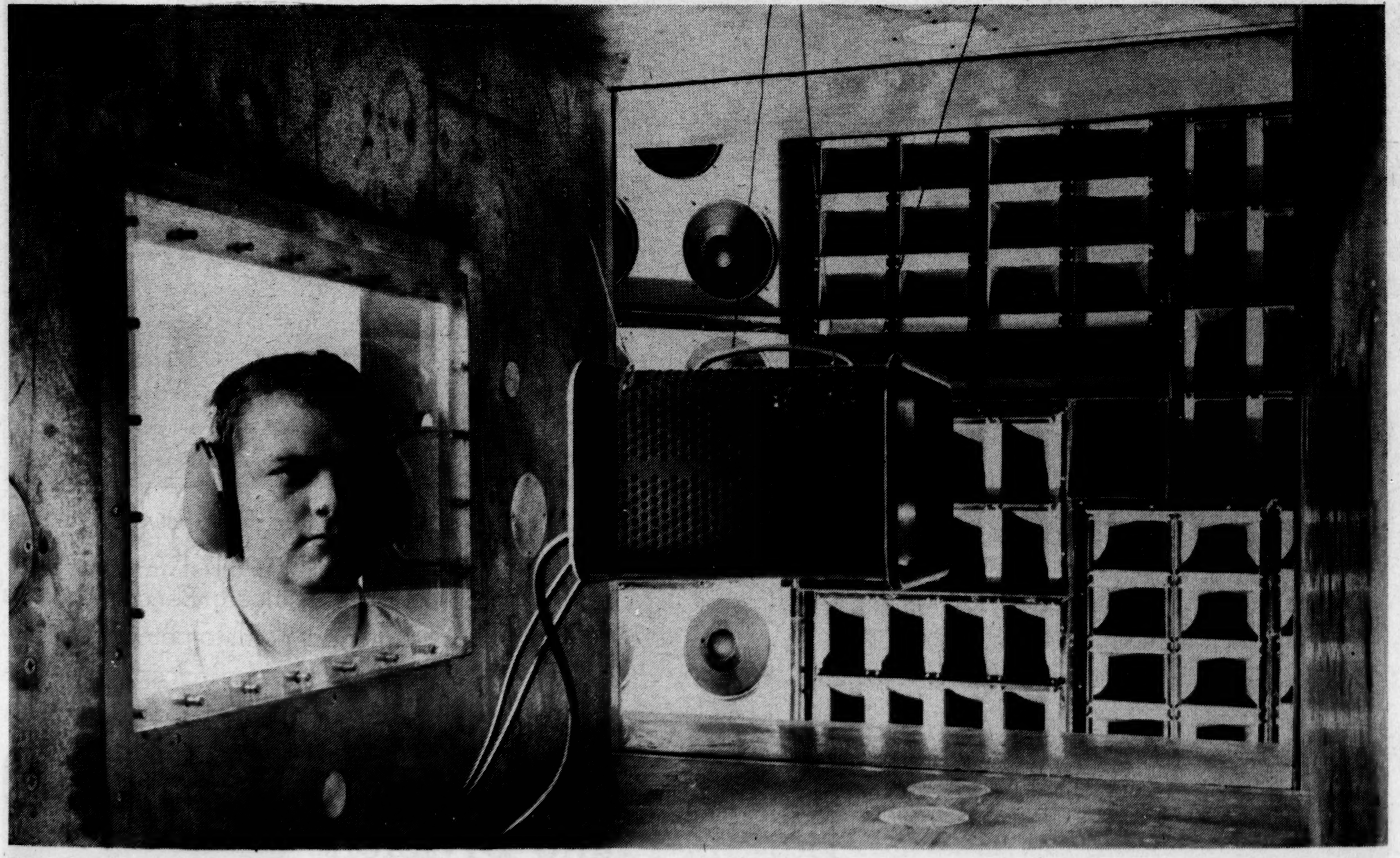
Chamber Simulates Rocket Noise Levels

Huge acoustical test chamber, installed by Goodyear Aircraft Corp. at its Litchfield Park (Arizona) plant, can create different types and intensities of noise at sound levels up to 150 decibels and frequencies ranging from 37 to 10,000 cycles per second.

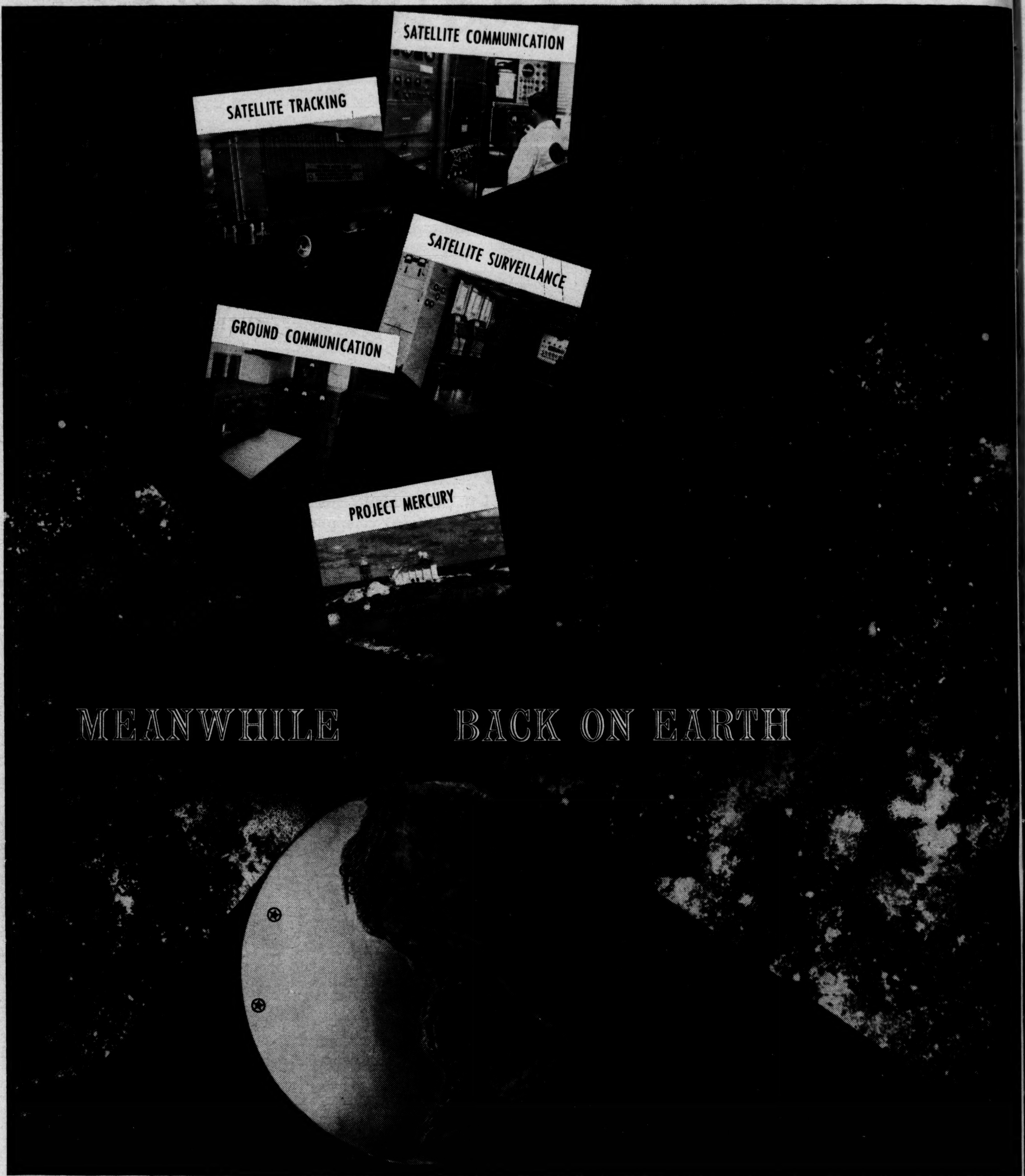
The sound chamber, which is part of the company's new million-dollar environmental testing facility, will be used to test various aircraft and missile components produced by the company, ranging from metal and plastic parts to electronic instruments. Flanking the acoustical chamber and capable of being tied together for multi-environment testing are a vibration platform, a temperature-altitude-humidity chamber and a shock machine.

With the new sound chamber, says Goodyear, scientists are able to duplicate the type of noise produced by any jet engine or rocket powerplant.

Briefly, this is how the unit works:



COMPONENT being tested in Goodyear's environmental chamber at Litchfield Park, Ariz., is suspended from elastic cords designed to isolate it from chamber's mechanical vibrations. Technician is wearing liquid-filled noise protectors.


SATELLITE COMMUNICATION
SATELLITE TRACKING
SATELLITE SURVEILLANCE
GROUND COMMUNICATION
PROJECT MERCURY
MEANWHILE BACK ON EARTH

systems integration There is an efficient, money-saving formula for answering range instrumentation and communication network problems. It is to take proved equipment, modify it as necessary, design anew where required for system optimization, and package for the specific need. Bendix Radio is already doing this for MINITRACK, SPASUR, MERCURY, CRITICOM Interim and point-to-point communications. The operational effectiveness of these Bendix Radio fixed and mobile systems is exceptional. The same kind of performance—at minimum cost—is available to you. So, if you're looking for a down-to-earth solution to a systems integration problem, see us. Write today for a copy of our new SYSTEMS INTEGRATION booklet.

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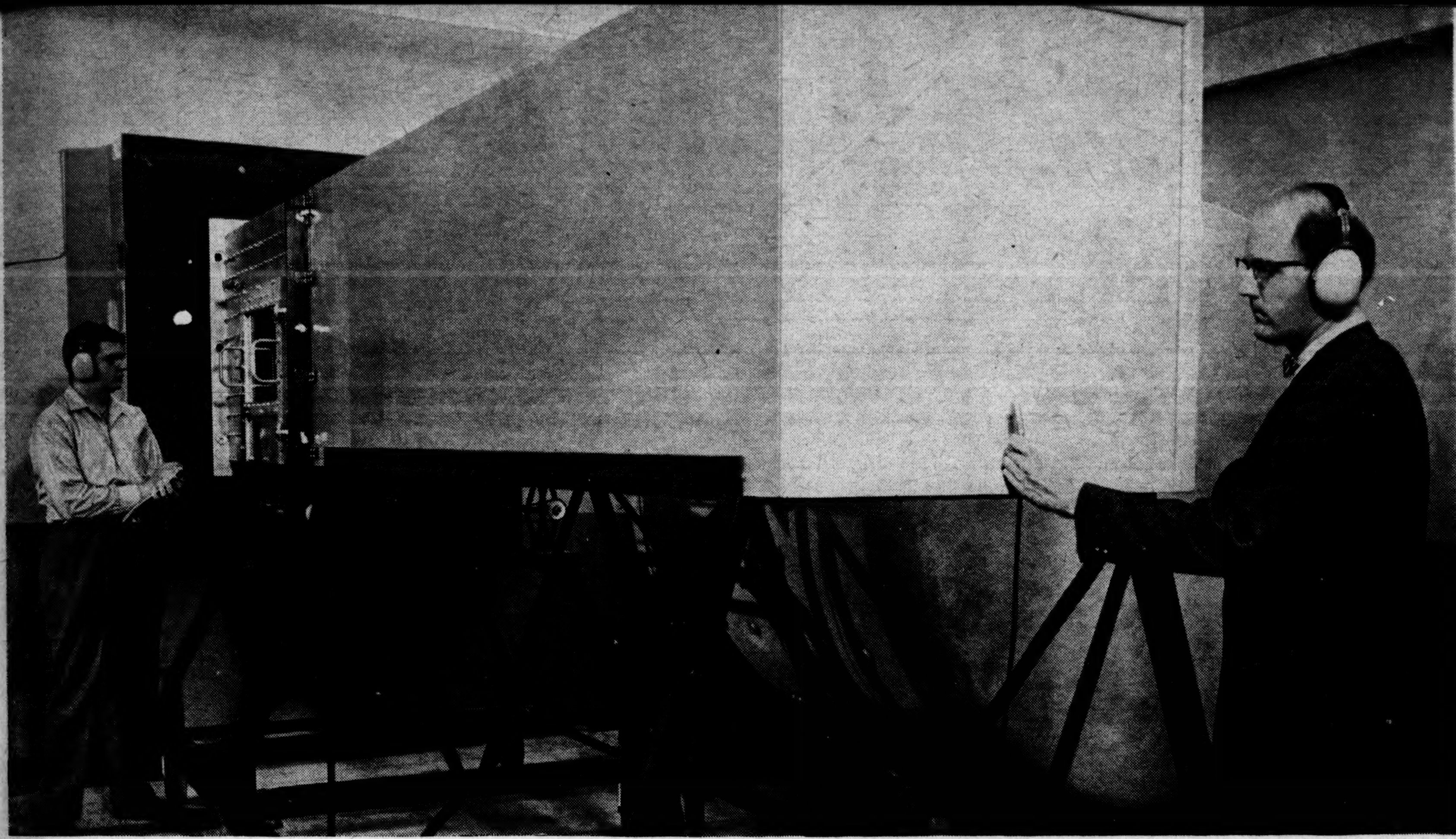


NOISE LEAKAGE is monitored at end of sound sink filled with foam plastic wedges which absorb noise after it comes out of chamber.

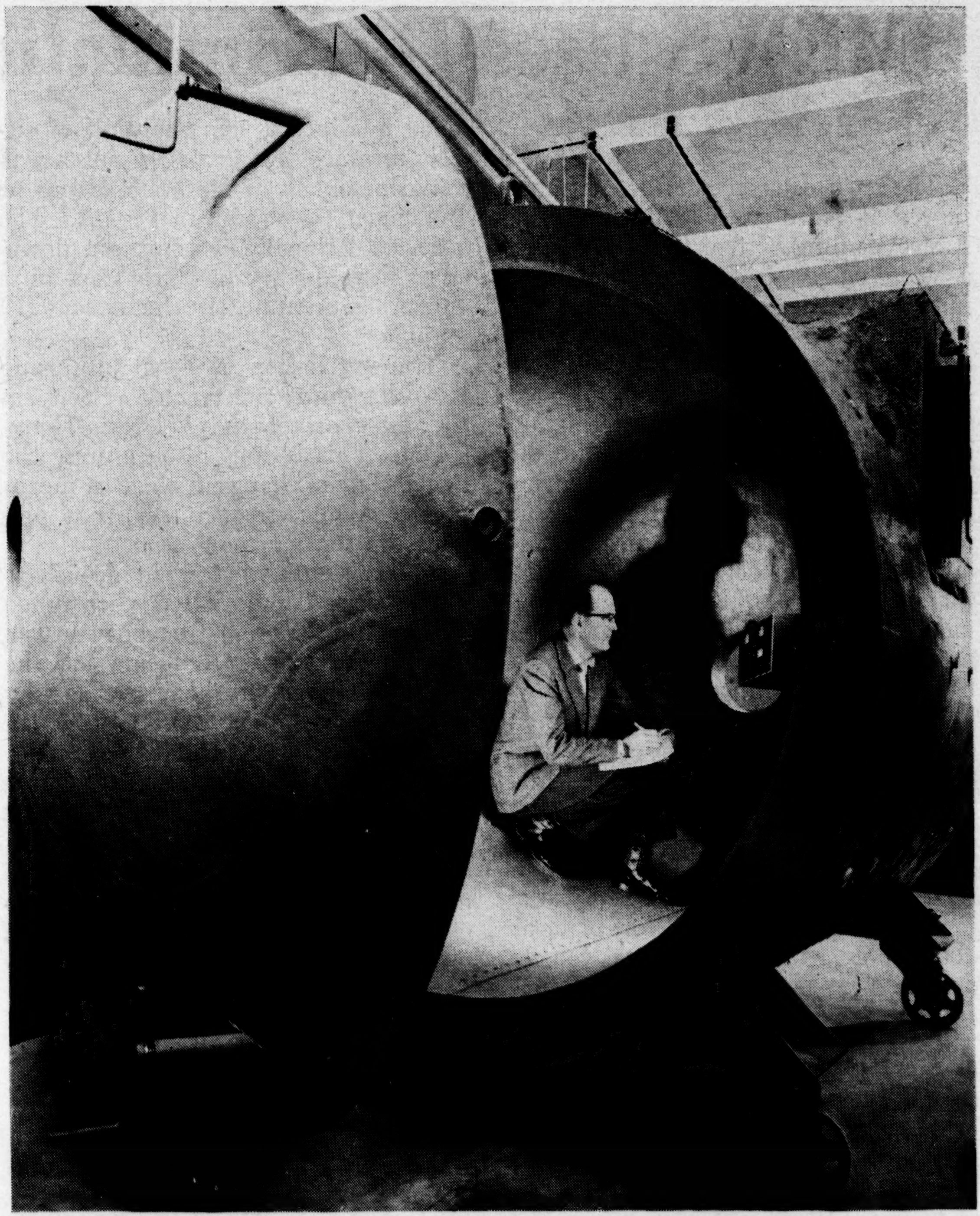
electric current is passed through a zener diode which generates a "peep-like" sound. The frequency spectrum of the sound is tailored to the test in progress by a technician. Then the peep is fed into twin amplifiers, each with a peak rating of 10 kilowatts. From the amplifiers, the sound goes to a big horn which has 112 loudspeakers, 48 in the bass range and 64 in mid-range.

The horn opens into a test room where a 4-in.-thick insulating blanket helps channel the sound with minimum loss. Walls of the test chamber are 1-in.-thick duraluminum.

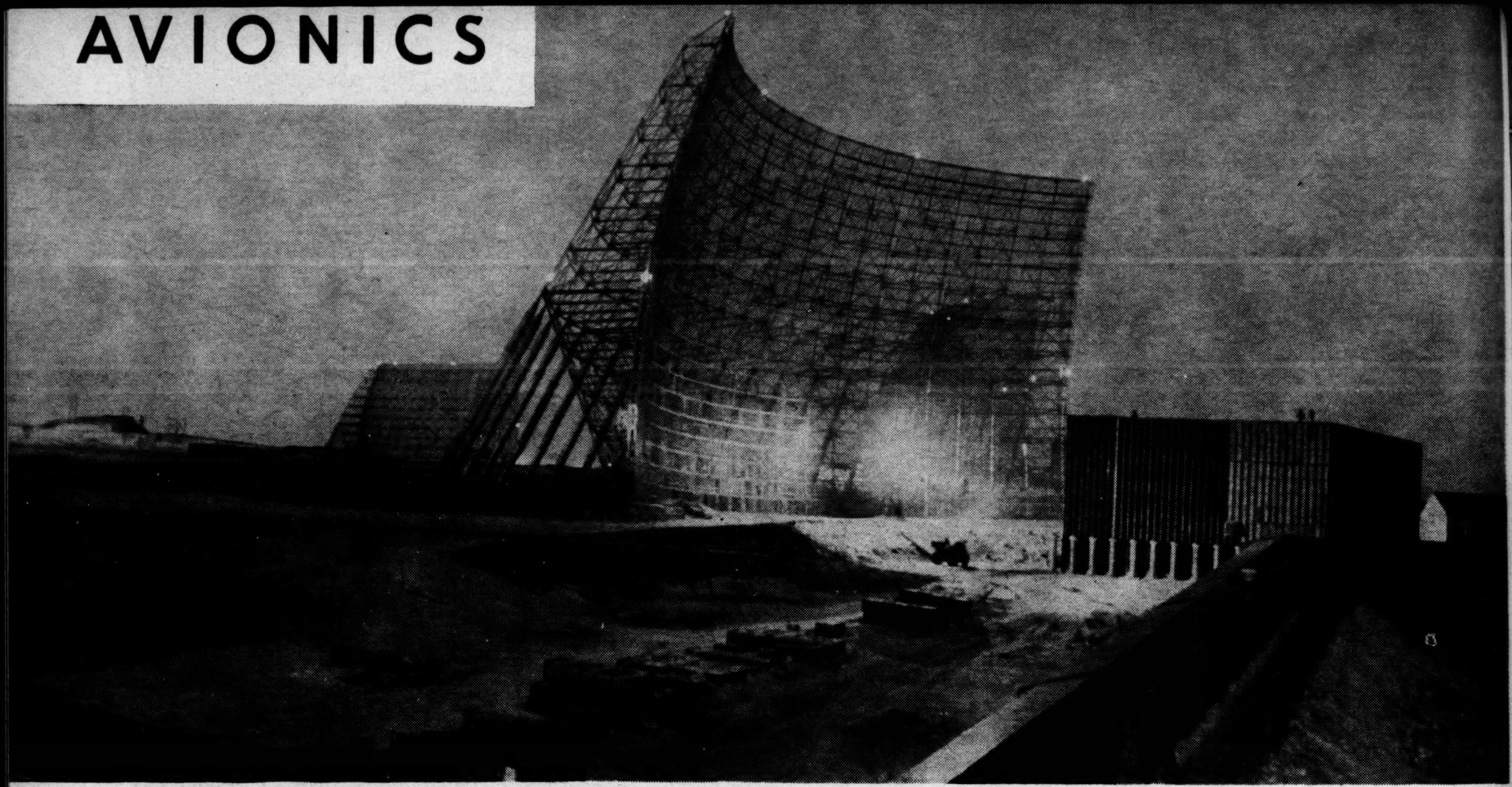
In the chamber, the component under test is suspended on a rubber shock cord which isolates it from mechanical vibrations of the chamber. From the test chamber the sound waves pass into a large box filled with baffling wedges of urethane foam, where the noise is made tolerable to technicians wearing liquid-filled earmuffs.

In addition to two square testing chambers, Goodyear engineers use a cylindrical reverberant chamber forged of $\frac{3}{8}$-in. steel for certain tests in which it is desired to bombard the component with sound from all directions.

The shaker facility, according to Goodyear, can produce vibrations through a range of 5 to 2,500 cps. The temperature-altitude chamber can simulate temperatures from −100F to 500F and altitudes from 1,000 to 150,000 ft. above sea level with precise humidity control. The shock machine, with a component fall of a few feet, can produce a force equivalent to 70g. A 15g force generally is used for impact testing of aircraft electronic equipment.



REVERBERANT CHAMBER bombards components with sound from all directions. High-intensity sound is fed into chamber through side opening.



BALLISTIC MISSILE EARLY WARNING SYSTEM (BMEWS), now in operation near Thule, Greenland (above), and soon to become operational at Clear, Alaska, uses a variety of techniques to discriminate between missiles and harmless targets such as meteors and satellites.

BMEWS Uses Discrimination Techniques

By Philip J. Klass

The radar data processing system employed in Air Force's Ballistic Missile Early Warning System (BMEWS) uses a wide range of discrimination techniques to distinguish between threatening missiles and harmless reflectors of radar energy, such as meteors and satellites.

Unlike the problem of detecting air-breathing vehicles, where these are the only large reflectors of radar energy moving in the atmosphere, the missile nose cones which BMEWS must detect may be poorer reflectors of radar energy than meteors, satellites and aurora. The radar energy reflected from an ICBM nose cone may be as small as one billionth of a millionth of a watt.

This requires that threats be sorted from harmless radar reflectors by examining the object's trajectory, velocity, rate-of-change of velocity, its origin and its apparent destination.

Furthermore, threat identification must be both swift and positive because there is no second or third line of radar defense, as with air-breathing vehicle detection, to permit later confirmation and still provide military reaction time.

The AN/FPS-50 detection radars, built by General Electric for Radio Corp. of America, which is BMEWS prime contractor, generate two fan-shaped beams which are separated vertically by several degrees. The two beams scan in azimuth simultaneously.

When a reflecting object is encountered by a beam, the amplitude of signals returned by successive pulses will vary sinesoidally as the beam sweeps by the target, as shown in Fig. A. The received RF pulse is converted downward in frequency in three steps by a three-stage intermediate frequency (IF) amplifier.

The initial step in signal processing is to determine the target's velocity in the direction of the Western Hemisphere. This is done by measuring the target's rate-of-change in range by means of the doppler frequency shift it produces on the returning echo.

The IF signal is fed simultaneously to a number of doppler filters, each tuned to a slightly different frequency spaced around the center frequency of the radar. Although several of the doppler filters will pass some of the IF signal, the one which passes the highest amplitude indicates the doppler shift component of target velocity along the radar beam. Following each doppler filter is a video detector that extracts the video pulse shape of the target. These video outputs are then fed to the Data Takeoff subsystem for additional processing.

Data Takeoff

The Data Takeoff subsystem (Fig. B), built by Sylvania, performs the following functions on the incoming video signals:

- **Determines when doppler** filter output exceeds a given threshold.
- **Selects doppler filter** whose output is maximum for any particular target.
- **Determines range of the target.**
- **Correlates several pulse returns** ("hits") obtained during single scan across a target.
- **Determines target's** azimuth position.

Threshold detection and filter selection are performed by analog circuits that continuously compare the output voltages from all doppler filters with a pre-established threshold value. When this value is exceeded, indicating the presence of a possible target, a digital output (word) is generated which identifies the doppler filter and gives the amplitude of the signal.

The digital signal goes to the range detector which measures the elapsed time between transmission and receipt of the pulse, which indicates target range. This information is stored in a temporary magnetic core memory so it can be compared with subsequent radar returns from the same target during the same scan.

This is accomplished in what is called "hit-to-hit correlation circuits," where the range, velocity and azimuth of subsequent radar returns from the same target are compared. If the initial radar echo was a spurious one, produced by random noise, there will be no subsequent correlation, in all probability. But if the return is from a target, as indicated by subsequent pulses which show approximately the same azimuth, range and velocity, then a target report is sent to the Data Takeoff subsystem output switch. The report consists of a digital word containing information on target signal amplitude, doppler filter number, azimuth and range.

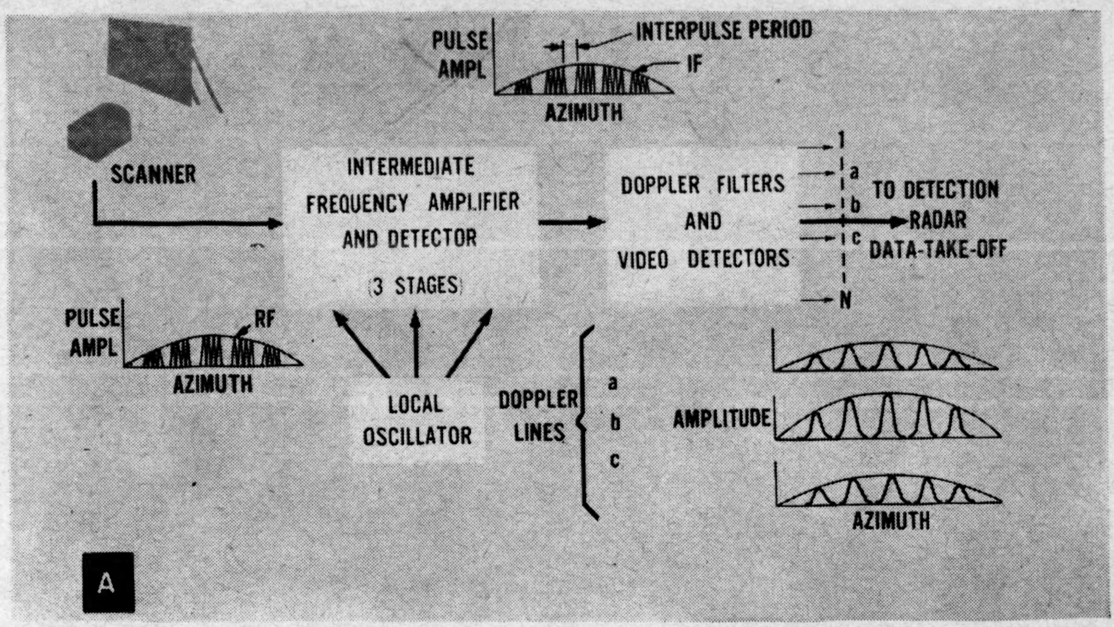
The Data Takeoff contains a large number of correlation circuits, one for each possible target which might be under simultaneous surveillance. Their outputs are connected into an IBM 7090 digital computer by means of a switch which sequentially scans all correlation circuits looking for possible target reports.

Target Filtering

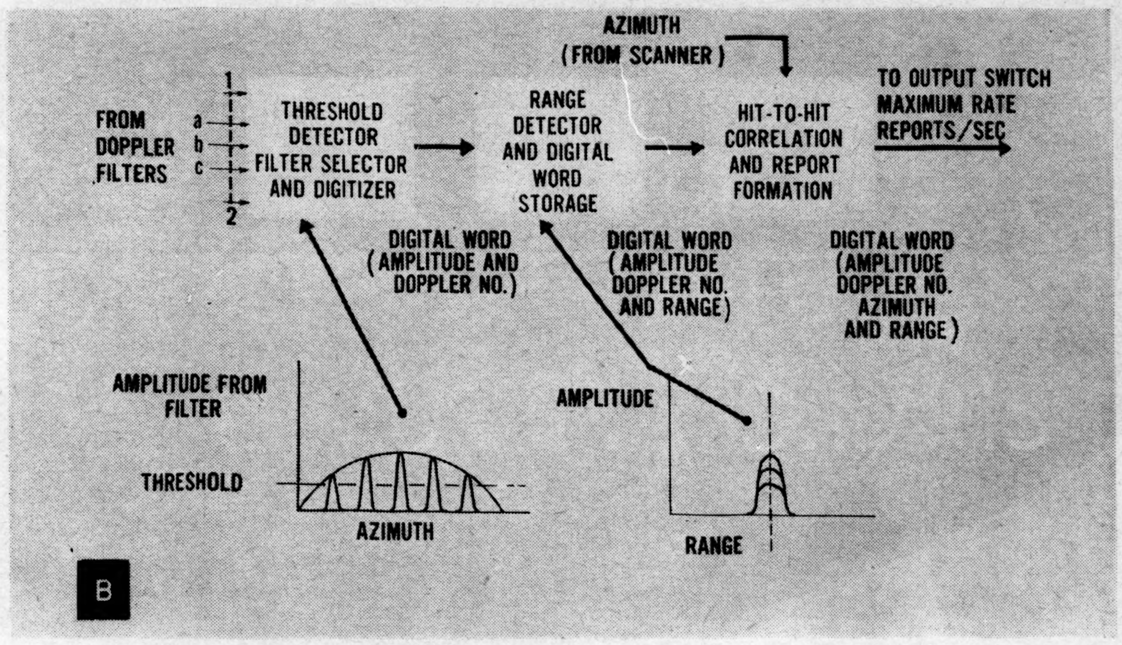
The 7090 computer, or Missile Impact Predictor as it is called, performs a series of analyses on incoming target reports, progressively filtering out the harmless targets until only the hazardous ones remain (Fig. C).

The series of analyses includes the following operations:

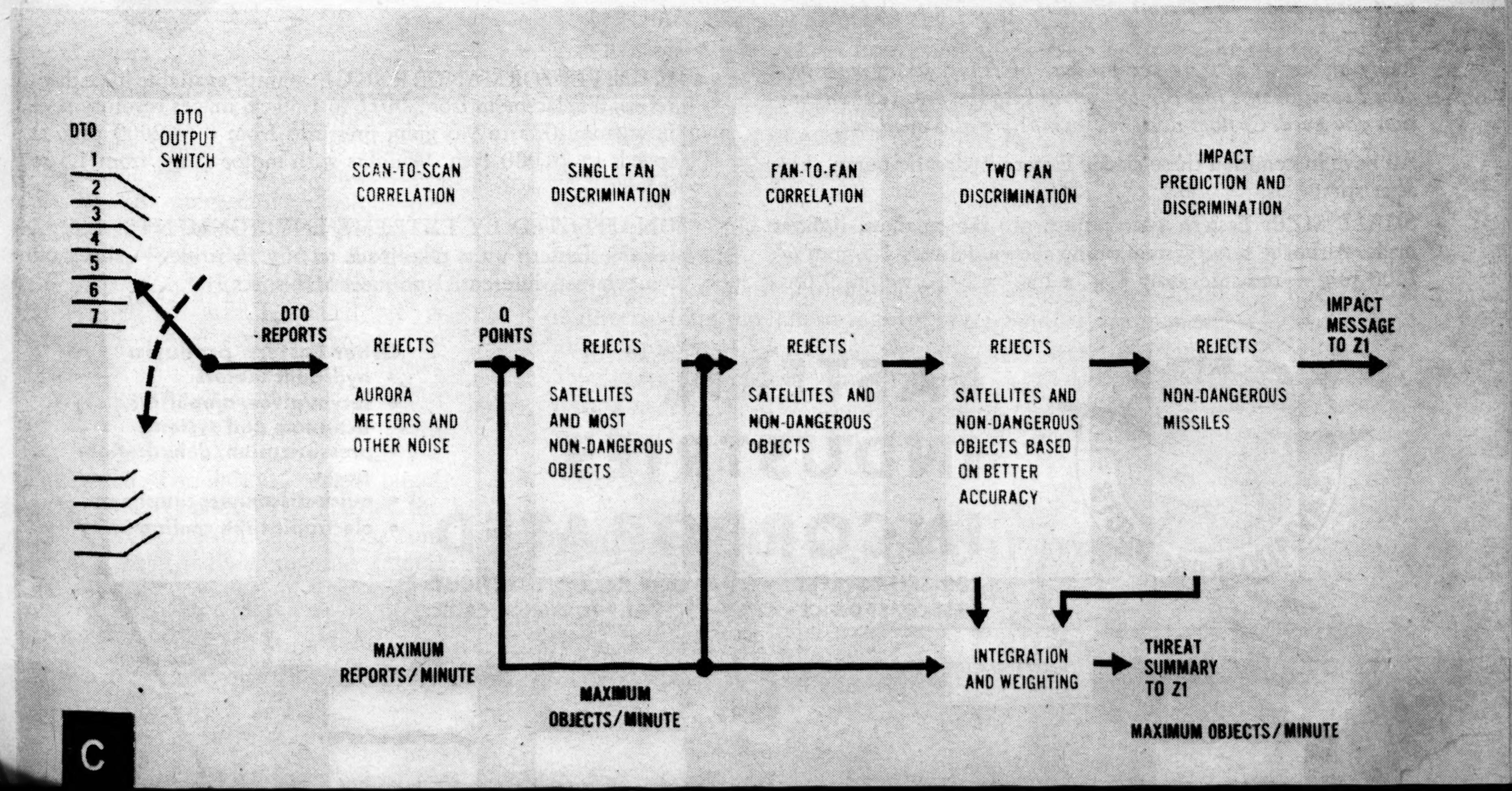
- **Scan-to-scan correlation:** This step is employed to detect radar signals which come from aurora, meteors and other noise (Fig. D). Target reports from successive scans of the radar beam on the same target are compared with previous reports to determine if the target's latest reported azimuth, range and velocity are within acceptable limits of the earlier data. These limits are based on known velocities of ballistic missiles. If each successive target report meets this criteria, it is added onto the earlier one to form a "chain" of reports on the target. When a required number of such links in the chain have met the scan-to-scan correlation criteria, the chain is consolidated in a single digital word, called a "Q-point."
- **Single fan discrimination:** This step


PULSE AMPL
INTERPULSE PERIOD
IF
AZIMUTH
SCANNER
INTERMEDIATE FREQUENCY AMPLIFIER AND DETECTOR
(3 STAGES)
DOPPLER FILTERS AND VIDEO DETECTORS
1
a
b
c
N
TO DETECTION RADAR DATA-TAKE-OFF
PULSE AMPL
RF
AZIMUTH
LOCAL OSCILLATOR
DOPPLER LINES
a
b
c
AMPLITUDE
AZIMUTH
A

BMEWS radar signals reflected back to antenna pass through three-stage intermediate frequency amplifier and then feed into doppler filters, each tuned to a slightly different frequency, to measure target's velocity, as shown in Fig. A. Signals then go to Data Takeoff subsystem (Fig. B) where those that exceed a given value are subjected to "hit-to-hit" range correlation to sort out real targets from spurious noise.


AZIMUTH (FROM SCANNER)
FROM DOPPLER FILTERS
1
a
b
c
2
THRESHOLD DETECTOR FILTER SELECTOR AND DIGITIZER
RANGE DETECTOR AND DIGITAL WORD STORAGE
HIT-TO-HIT CORRELATION AND REPORT FORMATION
TO OUTPUT SWITCH MAXIMUM RATE REPORTS/SEC
DIGITAL WORD (AMPLITUDE AND DOPPLER NO.)
DIGITAL WORD (AMPLITUDE DOPPLER NO. AND RANGE)
DIGITAL WORD (AMPLITUDE DOPPLER NO. AZIMUTH AND RANGE)
AMPLITUDE FROM FILTER
THRESHOLD
AZIMUTH
AMPLITUDE
RANGE
B

DETAILED ANALYSIS of apparent target signals is made by IBM 7090 computer, starting with a scan-to-scan correlation intended to discard signals produced by meteors and aurora. Any target report that gets past this stage is considered a potential ICBM and is given a threat evaluation rating based on how closely it exhibits ICBM characteristics. Later analysis includes a single-fan discrimination and fan-to-fan correlation which discriminate between satellites and missiles, followed by a two-fan and impact prediction discrimination.


DTO
DTO OUTPUT SWITCH
1
2
3
4
5
6
7
DTO REPORTS
SCAN-TO-SCAN CORRELATION
REJECTS
AURORA METEORS AND OTHER NOISE
Q POINTS
SINGLE FAN DISCRIMINATION
REJECTS
SATELLITES AND MOST NON-DANGEROUS OBJECTS
FAN-TO-FAN CORRELATION
REJECTS
SATELLITES AND NON-DANGEROUS OBJECTS
TWO FAN DISCRIMINATION
REJECTS
SATELLITES AND NON-DANGEROUS OBJECTS BASED ON BETTER ACCURACY
IMPACT PREDICTION AND DISCRIMINATION
REJECTS
NON-DANGEROUS MISSILES
IMPACT MESSAGE TO Z1
MAXIMUM REPORTS/MINUTE
MAXIMUM OBJECTS/MINUTE
INTEGRATION AND WEIGHTING
THREAT SUMMARY TO Z1
MAXIMUM OBJECTS/MINUTE
C

BULLETIN
EASTERN AVIATION PRODUCTS

your map
in a **UNIVERSE**
of AIRCRAFT PUMPS

This new engineering bulletin leads you right to the hydraulic pump designs you may be looking for. Here, passing on parade, are high performance gear pumps made to the measure of the next generation in aircraft, missiles, spacecraft, and support equipment.

Many of these units are the product of ready-made, mass-produced components that can be teamed into the precise configuration you need. Custom-designed pumps are also available.

All have in common these classic Eastern hydraulic pump characteristics:

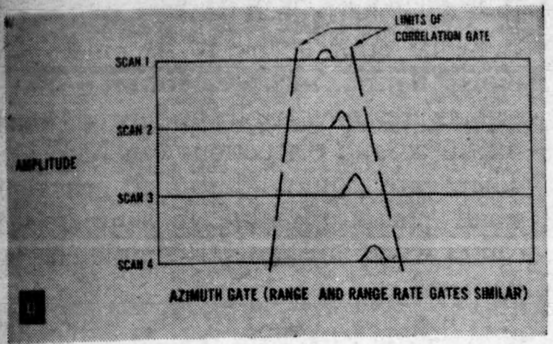
SMALL SIZE: Eastern gear pumps are the smallest, lightest made. Airborne servo system pump shown delivers 1.5 gpm @ 1500 psig — measures only 1⅞" x 1⅞" x 2¾", weighs 9 oz.

WIDE PERFORMANCE RANGE: pumps available have theoretical displacement from .0016 to 1.30 cu. in. per revolution — flow from .025 to 9.6 gpm, pressures from 0 to 2000 psig, at speeds to 24,000 rpm. Weights with motor range from 1.5 to 8.5 lbs.

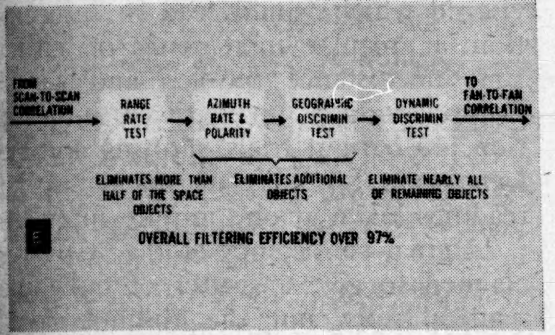
UNAFFECTED BY EXTREME ENVIRONMENTS: rugged, reliable Eastern units take loads to 50g in stride — shrug off temperature differentials to meet MIL specs.

**EASTERN
INDUSTRIES
INCORPORATED**
**100 SKIFF STREET • HAMDEN 14, CONNECTICUT
WEST COAST OFFICE • 4203 SPENCER ST. • TORRANCE, CALIF.**

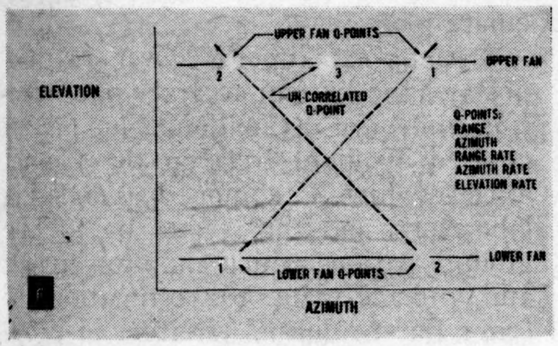
Other Eastern products:
- **hydraulic motors**
- **servovalves, amplifiers, actuators and systems**
- **pressurization/dehydration packs**
- **quick-disconnect couplings**
- **electronic tube cooling units**



SCAN-TO-SCAN correlation compares the target's apparent azimuth, range and range rate on successive radar beam scans. Echoes returned by meteors and aurora will lack correlation, enabling their signals to be rejected.


FROM
SCAN-TO-SCAN
CORRELATION
RANGE
RATE
TEST
AZIMUTH
RATE &
POLARITY
GEOGRAPHIC
DISCRIMIN
TEST
DYNAMIC
DISCRIMIN
TEST
TO
FAN-TO-FAN
CORRELATION
ELIMINATES MORE THAN HALF OF THE SPACE OBJECTS
ELIMINATES ADDITIONAL OBJECTS
ELIMINATE NEARLY ALL OF REMAINING OBJECTS
E
OVERALL FILTERING EFFICIENCY OVER 97%

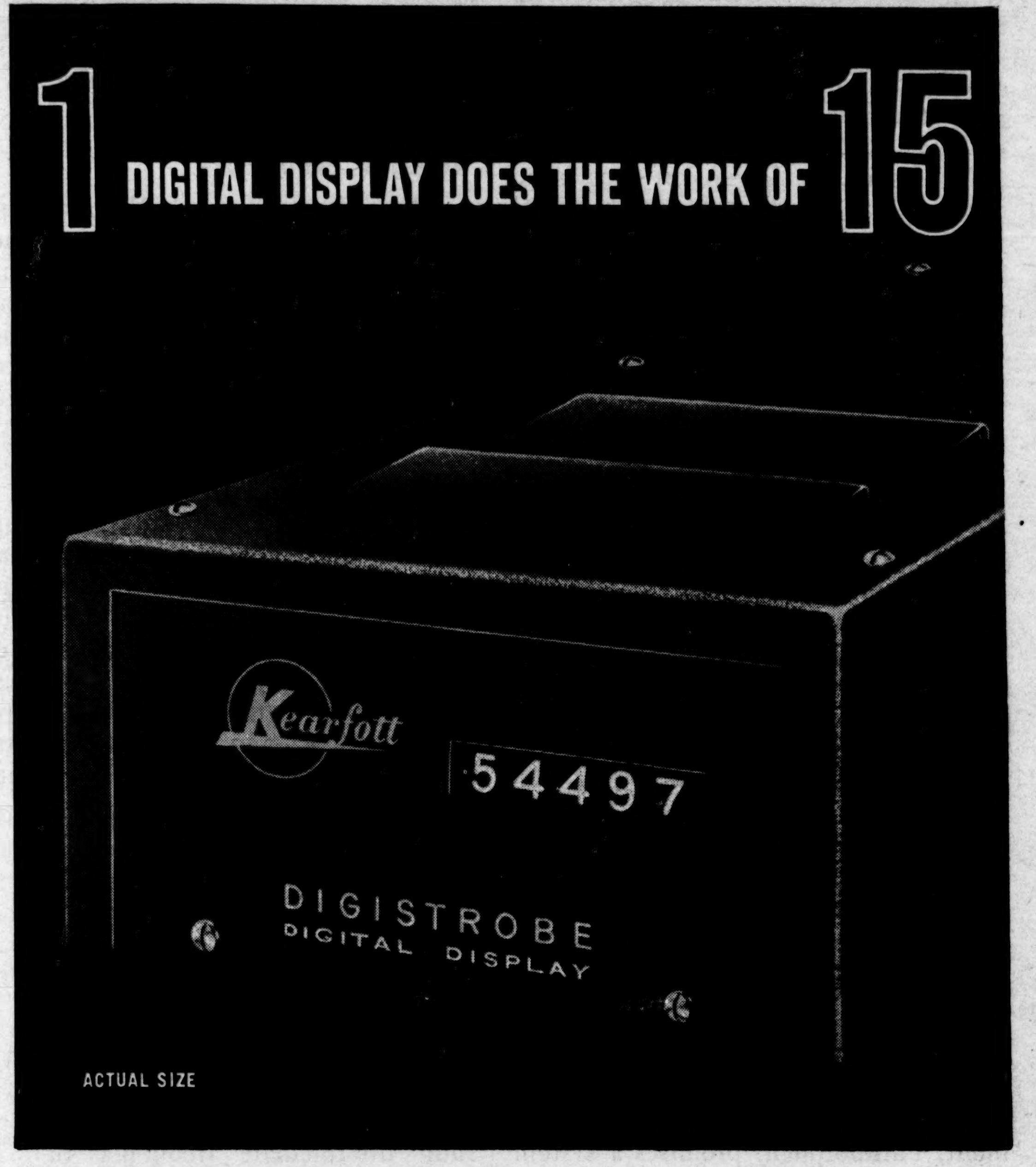
SINGLE fan discrimination is intended to sort missiles' trajectories from those of satellites by analysis of target closure rate, azimuth rate and heading, as well as apparent launch point.


UPPER FAN Q-POINTS
UPPER FAN
2
3
1
ELEVATION
UN-CORRELATED
Q-POINT
Q-POINTS:
RANGE
AZIMUTH
RANGE RATE
AZIMUTH RATE
ELEVATION RATE
LOWER FAN
1
2
LOWER FAN Q-POINTS
F
AZIMUTH

FAN-TO-FAN discrimination, using data obtained from target's penetration of two separate radar beams, permits more precise determination of target's trajectory and prediction of its impact area.

is expected to reject target reports from most satellites and other non-dangerous objects (Fig. E). From information on the target obtained by its passage through one of the two radar beams, including its range-rate velocity, azimuth rate, its polarity (whether it is coming up from the earth or down from space), and the geographic point from which it was launched, it is possible to discard certain targets. For example, a ballistic missile must always penetrate the lower beam first, while a satellite may intercept the top beam first.

- **Fan-to-fan correlation.** Any target report chain (Q-point) that passes the single-fan discrimination test is considered a potentially dangerous target. It receives an even weight that contributes immediately toward the "threat evaluation count"—a scoring system for rating the likelihood that an object is


1 DIGITAL DISPLAY DOES THE WORK OF 15
Kearfott
54497
DIGISTROBE
DIGITAL DISPLAY
ACTUAL SIZE

NEW KEARFOTT DIGISTROBE* DISPLAY

Kearfott's new, highly compact Digistrobe digital display utilizes the stroboscopic principle to produce an exceptionally high-definition readout in the actual size shown here. Through the use of a unique shutter arrangement, a single diode-encoding matrix is shared by all columns (5 in the standard model), resulting in substantial savings in electronic components and circuitry. The fast response time of the Digistrobe (56 milliseconds transition from one five-digit quantity to a totally different one) permits a single unit to sample several different inputs on command through an input selector switch. Up to 15 individual displays of existing types can thus be replaced by a single Kearfott Digistrobe!

Incorporating only two moving parts and exclusively solid-state switching circuitry, the Digistrobe has extremely long life expectancy and requires minimum maintenance and service. Operation is directly from the output register of a computer, counter or allied equipment, eliminating the cost of intervening circuitry. Two years of extensive laboratory tests assure compliance with Kearfott's rigid standards of quality. For complete data and specifications, write for Digistrobe bulletin.

*Kearfott Trademark

KEARFOTT DIVISION
GENERAL PRECISION, INC.
Little Falls, New Jersey

an attacking ICBM. In the fan-to-fan correlation procedure (Fig. F), the computer calculates how long it should take the unknown target, if it is an ICBM attacking North America, to pass from the lower to the upper radar beam, and what its azimuth position and range should be at that instant. If the target penetrates the upper beam within acceptable limits of the computed time and at the computed azimuth, the target is considered to be a ballistic missile.

- **Impact prediction** and discrimination: The final step is to compute the expected impact area for the missile, based on data obtained from its penetration of both the lower and upper radar beams. The dual penetration provides information on the target's latest azimuth, its rate-of-change of azimuth, its elevation rate, its range and its range rate. Targets which are calculated to impact outside the area to be warned can be eliminated at this point. After the target vector established by the dual fans has passed the impact prediction criteria, it is given a higher weight which is registered in the threat-summarizing process.

Impact Predictor

The Missile Impact Predictor prepares two types of messages for transmission to the United States. The first type is a summary of all threats which have successfully passed discrimination checks through the scan-to-scan correlation, plus a threat evaluation count which appraises the probability of the threat being a ballistic missile attacking North America.

The second type of message formulated by the computer gives an estimate of the expected impact area for each threatening target, the area from which the missile was launched, and the expected time to impact.

This information is simultaneously displayed at Norad Headquarters, Strategic Air Command Headquarters, and in Washington.

British Test VLF Radio System For World Navigation Coverage

London—VLF radio-navigation system research currently being carried out by the Royal Aircraft Establishment, Farnborough, promises a system indicating position to one to two nautical miles, using only six ground stations to give worldwide coverage. Current work is a feasibility study only, not development of a commercial system, and the future timescale is uncertain, but it is believed that the current research phase will be completed within three years and a developed system within 10 years.

A four-part flying program is under way, of which the first two phases are complete and the third is scheduled for early summer of this year. Using two ground stations—GBR at Rugby and NBA at Balboa, Panama—flights have been made successfully from Farnborough to Nairobi as well as to several Mediterranean airfields with extremely small error even when the flight path was deliberately complicated.

RAF envisages a network of six ground stations at the corners of a regular octahedron which would mean at least three stations would always be within range of an aircraft. Only two are necessary to get a fix, because the system employs concentric circle intersections and the third would give redundant information, only necessary if the signal from another station were lost.

Basic airborne equipment for the system consists of a highly stable 5-mc. oscillator (current model gives stability to one part in 10 to the ninth power per week) and a twin-channel receiver with common oscillator giving a common intermediate frequency of 525 cps. to both channels. One channel is fed with a harmonic of the stable oscillator, the other with a signal from a ground station. Intermediate frequencies are summed and differenced into a geared servo resolver which indicates phase difference between the two signals and can be read to 1/20 of a wavelength. Present tests use two receivers—Rugby transmits on 16 kc. and Balboa on 18 kc. But a commercial system with its own ground stations would not have this complication.

Assuming that starting point position is known, increments of aircraft movement are determined in terms of changes of range from fixed transmitters. These distances are measured in terms of phase changes, the sum of unit changes plus a fraction.

Receiver bandwidth is 1 cps. and this enables normal transmissions from Rugby to be used, the receiver averaging fluctuations in signal amplitude. Reason for operating outside the internationally agreed frequency band of 10 to 14 kc. is solely that signals are available on the higher frequencies from several stations. It is not envisaged that a commercial system would operate outside the agreed waveband.

Major problem encountered so far is the diurnal variations in propagation which, for instance, make Malta appear three miles nearer Farnborough during the day than during the night, and cause an error of five to six miles on a cross-Atlantic flight. However, these errors are now well understood and measured and corrections can be made. There are some additional errors of small magnitude due to complicated causes which are not yet completely understood.

Noise does cause trouble, especially that which is due to tropical thunderstorms. On a flight to Nairobi from Farnborough the Rugby signal was intermittently swamped, but occasional glimpses of the signal proved enough to maintain course. In a commercial system a data processing computer is envisaged which would feed in information at regular increments of either time or distance traveled and would extrapolate gaps in received information. In current trials, plotting and extrapolation formulas are manual, from readings taken at one minute intervals.

Internal consistency of the system is claimed to give a scatter of only one nautical mile, but the absolute accuracy has not yet been determined. This is difficult to determine outside current Navaid areas within 10 naut. mi., says RAE, and photographic equipment is being installed in the Comet aircraft used for the tests to obtain more accurate plots.

Current experiments cover two aspects of the system: accuracy of navigation and error estimation. The first is covered by flight trials in the Comet aircraft which is equipped as a flying laboratory, and the second by mobile ground stations which monitor signals and provide data for estimation of errors due to diurnal variation in propagation and other causes.

Soon it is hoped to have a navigation display which will plot position on a circular lattice distorted to a Cartesian grid. This will decrease manual operations which are necessary at present. Later the display will be developed to give position on a latitude-longitude lattice. Experimental nature of the program is emphasized by the fact that there are no plans to develop an airborne computer for the system.

Advantages claimed by RAE for circular coordinates in a VLF system over the hyperbolic coordinates suggested by other sources (for instance the Decca Delrac system, which is currently only a paper study) are mainly applicable to research work. For instance the absolute error from each of the two ground stations in the RAE system can be computed simply, whereas with a three-station hyperbolic system only relative errors can be computed. However, the simplicity of mapping and computing with a circular system should make the RAE system a potent competitor in the Navaid spectrum when tests are completed.

FILTER CENTER

▶USSR Reports Aurora Radar Studies—Soviet tests indicate that conditions that produce visible auroras usually result in reflection of radar/radio energy from the same location. The brighter the visible aurora, the greater the strength of the reflected radar/radio signals, except during periods of serious magnetic disturbance. Results of the study, conducted by USSR Academy of Sciences Institute of Atmospheric Physics, is available in English translation from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Report, identified OTS: 60-41,286, costs 50 cents.

▶GE Opens Radio-Optical Observatory—New methods for optical detection of space vehicles and lunar reflection studies will be investigated by General Electric at its Radio-Optical Observatory, recently set up by the company's General Engineering Laboratory near Schenectady, N. Y. GE says the observatory is the first facility for research and development work in space communications, which permits simultaneous optical and radio tracking of space vehicles.

▶Guide for Contract Terminations—Electronic Industries Assn. will prepare a guidebook to assist contractors in settling contract terminations. The book is expected to be particularly helpful to smaller companies without extensive experience in terminations.

▶Transistor Specification Manual—Arinc Research Corp. has published a complete compilation of the latest specifications for all transistors listed on the Military Preferred List (MIL-STD-701A) and the Arinc Semiconductor Device Preferred List, for airline avionics use. The new Arinc Transistor Specification Manual, in loose-leaf binder, also contains abstracts of the latest commercial specifications for transistor types for which military specifications are not yet available. The manual is available at a price of $10.00 each to U. S. purchasers and may be ordered from Arinc Research Corp., 1700 "K" St. N.W., Washington 6, D. C.

▶More Efficient Transistor Sought—CBS Laboratories has launched a research program aimed at developing smaller, more efficient silicon switching transistors under sponsorship of the Army Signal Research and Development Laboratory. Objective is to cut internal power losses by a factor of several hundred, permitting more dense packaging without usual cooling problems.

▶New Name—ITT Federal Laboratories is the new name of the recently merged ITT Laboratories and ITT Federal Division, which will now operate as a single division of International Telephone & Telegraph Corp.

▶New Common Language for Computers—General Electric has developed new computer programing technique, called GECOM (for General Compiler) which automatically translates English language instruction into computer program code. The new GECOM permits a computer to accept many language-instruction techniques now in use, including COBOL (Common Business Oriented Language) and ALGOL (Algorithmic Language). New translation will be available in the spring for company's recently announced GE-225 general purpose computer and later for all GE computers, GE says. Radio Corp. of America and Remington Rand recently conducted first successful interchange of data between computers made by different manufacturers using instructions written in English in COBOL. Instructions prepared for use by a Remington Rand Univac II were subsequently fed into an RCA 501.

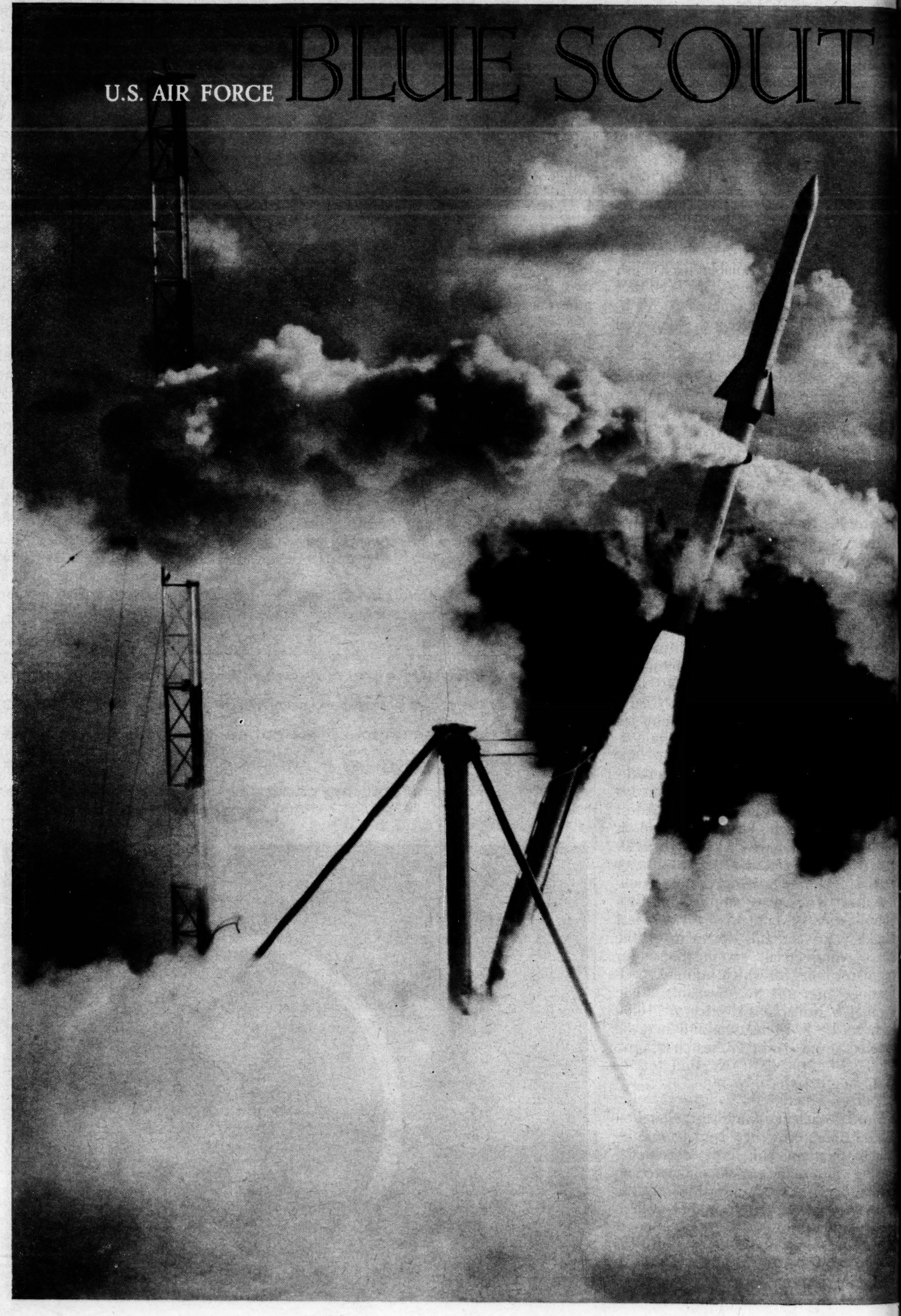
▶Signed on the Dotted Line—Major contract awards announced by avionics manufacturers include the following:

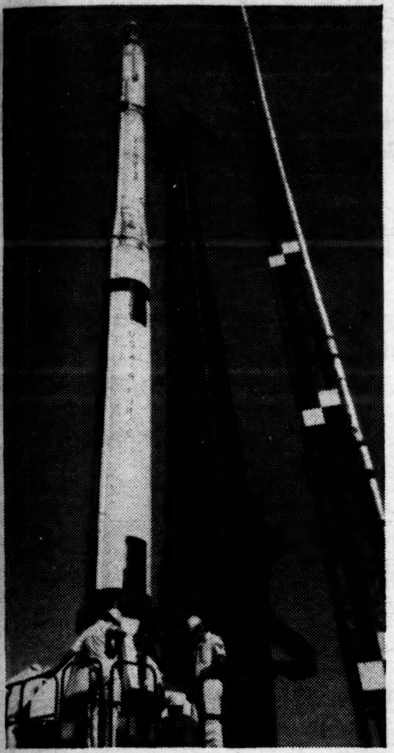
- **Radio Corp. of America,** Defense Electronics Products Division, Moorestown, N. J., Army contract for $1.1 million for additional work on Tradex radar to be installed on Roi-Namur in southwest Pacific for tracking ICBM nose cones.
- **Electronic & Missile Facilities, Inc.,** $1.7-million contract from Federal Aviation Agency to construct an air traffic control center at Slidell, La.
- **Radiation, Inc.,** Melbourne, Fla., $800,000 contract from Radio Corp. of America for tracking and communications antennas to be used for Dyna-Soar program. This initial contract is expected to be followed by manufacturing awards amounting to several million dollars, the company says.
- **Fairchild Camera & Instrument Corp.,** Syosset, N. Y., contract for more than $3 million from International Business Machines Corp. for production of ground support equipment for B-52 bomb-navigation systems which IBM produces.
- **Avien, Inc.,** Woodside, N. Y., contract for $620,000 from North American for limit detectors to be used for checkout of Hound Dog missile. Also, a contract for $575,000 from Air Force for a time-temperature recorder system used to measure engine operating characteristics on T-38 jet trainers.

WET SPACEMAN ■ The Null-Gravity Simulator—developed by Lockheed/Georgia — rotates submerged spacemen up to 80 r.p.m. to create the effects of weightlessness. This device in the Human Factors Laboratory is just one of the diverse aerospace research and manufacturing capabilities at the Georgia Division.

LOCKHEED/GEORGIA
MARIETTA, GEORGIA

U.S. AIR FORCE BLUE SCOUT





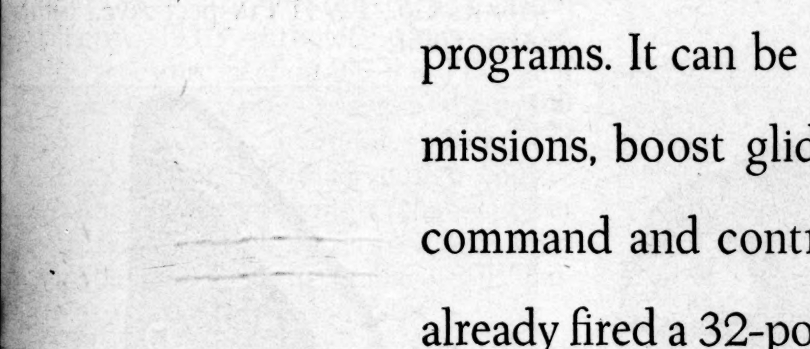
LEFT: USAF technicians of 6555th Test Wing under technical supervision of Aeronutronic engineers erect Blue Scout on simplified launch pad prior to successful flight. The development of Blue Scout effectively bridges gap between larger, more expensive ICBM's and smaller sounding rockets in our advanced space research and test programs. The Blue Scout is the largest solid fuel missile ever fired at Cape Canaveral.

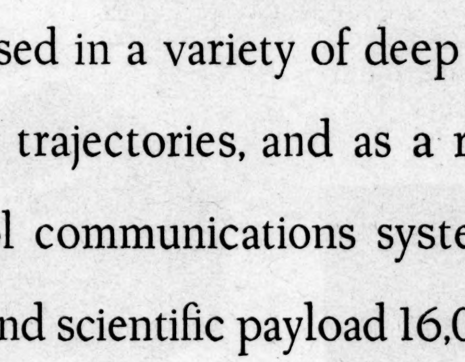
OPPOSITE: U. S. Air Force Blue Scout Jr., lifts off launch pad as spin rockets ignite. This unguided 4-stage missile was successfully launched on the first attempt.

U.S. AIR FORCE PHOTOS

The United States Air Force Blue Scout Program provides the Nation with a new and versatile low-cost family of test vehicles to support our military weapons and space systems development programs. It can be used in a variety of deep space probes, orbit missions, boost glide trajectories, and as a rocket and satellite command and control communications system. Blue Scout has already fired a 32-pound scientific payload 16,000 miles into space ... and a 392-pound payload in a controlled trajectory 1400 miles down the Atlantic Missile Range. Aeronutronic is systems engineer, payload and test contractor on this important Air Force program.

AERONUTRONIC DIVISION *Ford Motor Company,* DEFENSE PRODUCTS GROUP
FORD ROAD, NEWPORT BEACH, CALIFORNIA



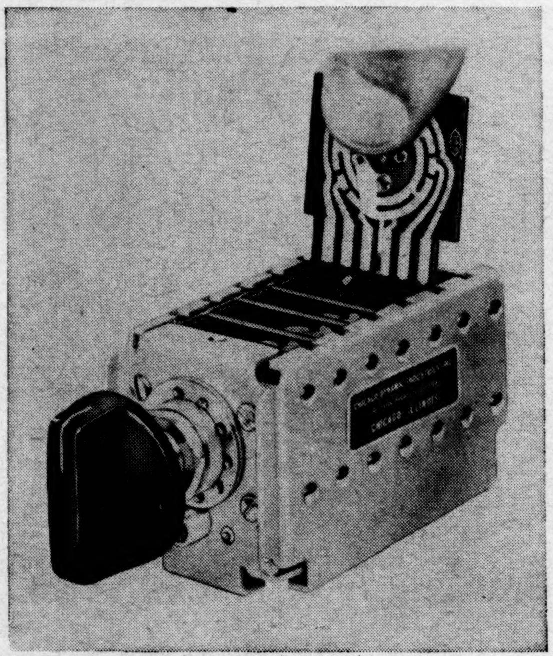


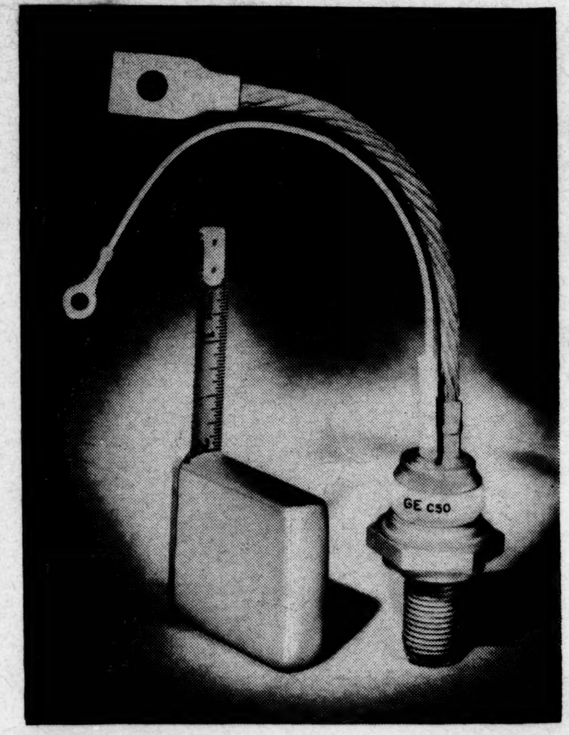
Write for information about Aeronutronic's capabilities and the career opportunities open for engineers and scientists.

The Blue Scout program, based on modifications of the NASA Scout, is under the executive direction of the U.S. Air Force Ballistic Missile Division, Air Research and Development Command. Above LEFT: Blue Scout is raised to a firing position on simplified launch pad. Because missile requires minimum ground support equipment, it is operable in a number of various field environments at minimum cost. *RIGHT:* Instrument package of Blue Scout is checked by Aeronutronic personnel and Air Force technicians. Accurate guidance system, data recovery system and final stage attitude control make Blue Scout adaptable to a wide variety of applications.

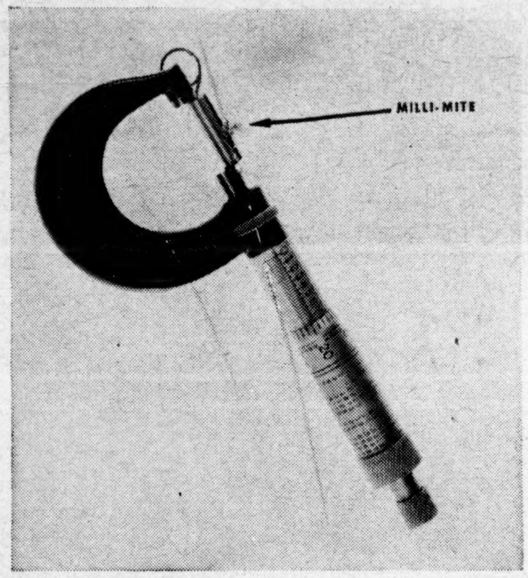
NEW AVIONIC PRODUCTS

• **Miniature removable wafer rotary switch,** Series RS-15, in which any wafer can be instantly removed without disassembling or unsoldering for cleaning or replacement, is available with up to 18 wafers in a 10-position single pole configuration. Typical switch with six wafers measures $1\frac{5}{8}$ x $1\frac{3}{8}$ x $2\frac{7}{8}$ in. Operation can be manual or motor driven. Manufacturer: Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill.

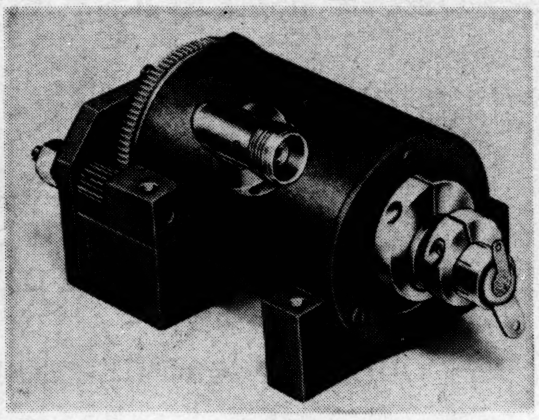




• **High-current controlled rectifiers,** silicon Model C50, offer average maximum forward current ratings of 70 amp. a.c. and 110 amp. d.c., in eight versions with peak reverse voltage ratings ranging from 25 to 400 v. Turn-on time is 1.0 to 4.5 microseconds, depending upon application, with turn-off times of 15 to 25 microseconds. Brochure No. 170.20 9/60 gives application data. Manufacturer: General Electric Co., Kelley Bldg., Liverpool, N. Y.



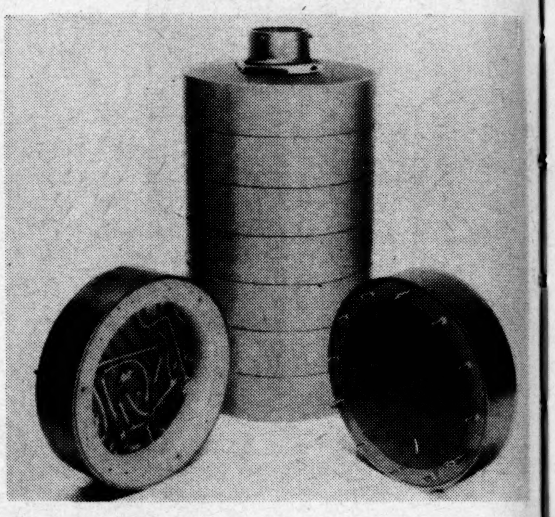
• **Miniature inertia switch,** Model 6U0-200, can be pre-set to react to acceleration forces up to 250g within a tolerance of 15% of the setting. Switch has only a single moving part, a precision-ground steel ball held against a solid base by a uniform magnetic field until applied acceleration exceeds this field force. Switch is designed to meet all environmental requirements of MIL-E-5272, including operation over temperature range of −65F to 200F, according to manufacturer: Inertia Switch, Inc., 311 West 43rd St., New York 36, N. Y.

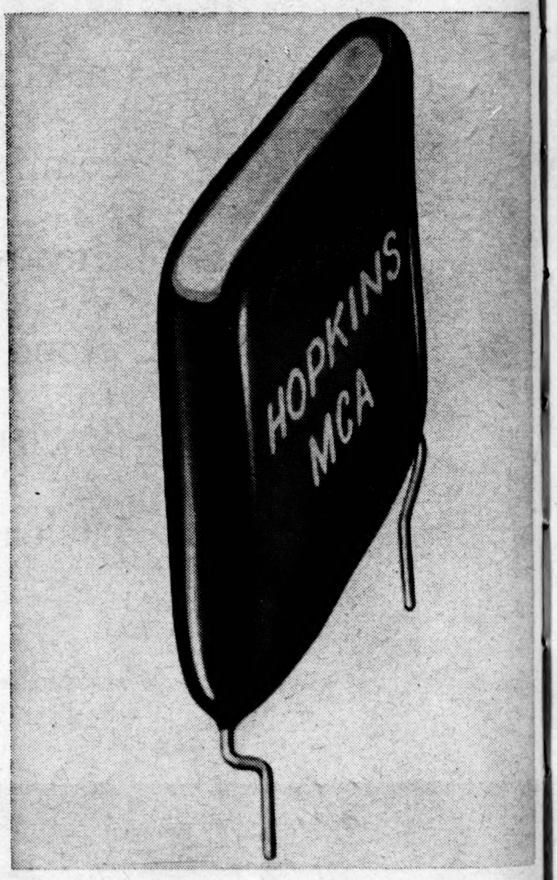


• **Pulsed triode oscillator,** Model 301C, delivers 1 kw. output at C-band and covers frequency range of 5,400 to 5,900 mc. by adjustment of a single tuning screw. Manufacturer says there is no mode skipping, less than 1 mc. pushing figures and no special pulse shaping is required. Tube will operate under 20g vibration 20 to 2,000 cps. and 100g shock for milliseconds. Temperature drift is 20 kc. per deg. C. Manufacturer: John Gombos Co., Inc., Webro Road, Clifton, N. J.

• **Wide band spectrum analyzer,** Model WSA, covers frequency range from 10 to 40,000 mc. in 20 bands with a display of up to 4,000 mc. Device can be used to simplify field intensity measurements, for testing transmitters and signal generators, checking broadband jamming systems and to determine pulse widths and shapes through spectrum analysis. Resolution is 20 kc. in narrow band and 1.5 mc. in wide band. Sweep repetition rate is adjustable between 1 and 30 cps. Nominal sensitivity ranges from −85 dbm. at 10 mc. to −50 dbm. above 18.5 mc. Manufacturer: Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y.

• **Circular stacked modules,** for convenient packaging of subsystem circuits, are available in variety of sizes and shapes with feed-through contacts to interconnect individual modules in the stack. Modules can be provided with printed circuit boards and feed-through contacts to customer requirements. Metal surfaces are color anodized. Manufacturer: Modular Electronics Co., 12941 Prospect Ave., Santa Ana, Calif.





• **Ultra-thin mylar capacitors,** Type MCA, operate from −55C to 100C without derating and up to 125C with 50% voltage derating. Power factor is less than 1% at 1 kc. and 25C, and insulation resistance is 75,000 megohms minimum at 100 v.d.c., 25C, according to manufacturer. Typical 0.01 mfd. unit measures 0.525 in. wide and only 0.225 in. thick. Manufacturer: Hopkins Engineering Co., 12900 Foothill Blvd., San Fernando, Calif.

EQUIPMENT

B-70 Secondary Power System Detailed

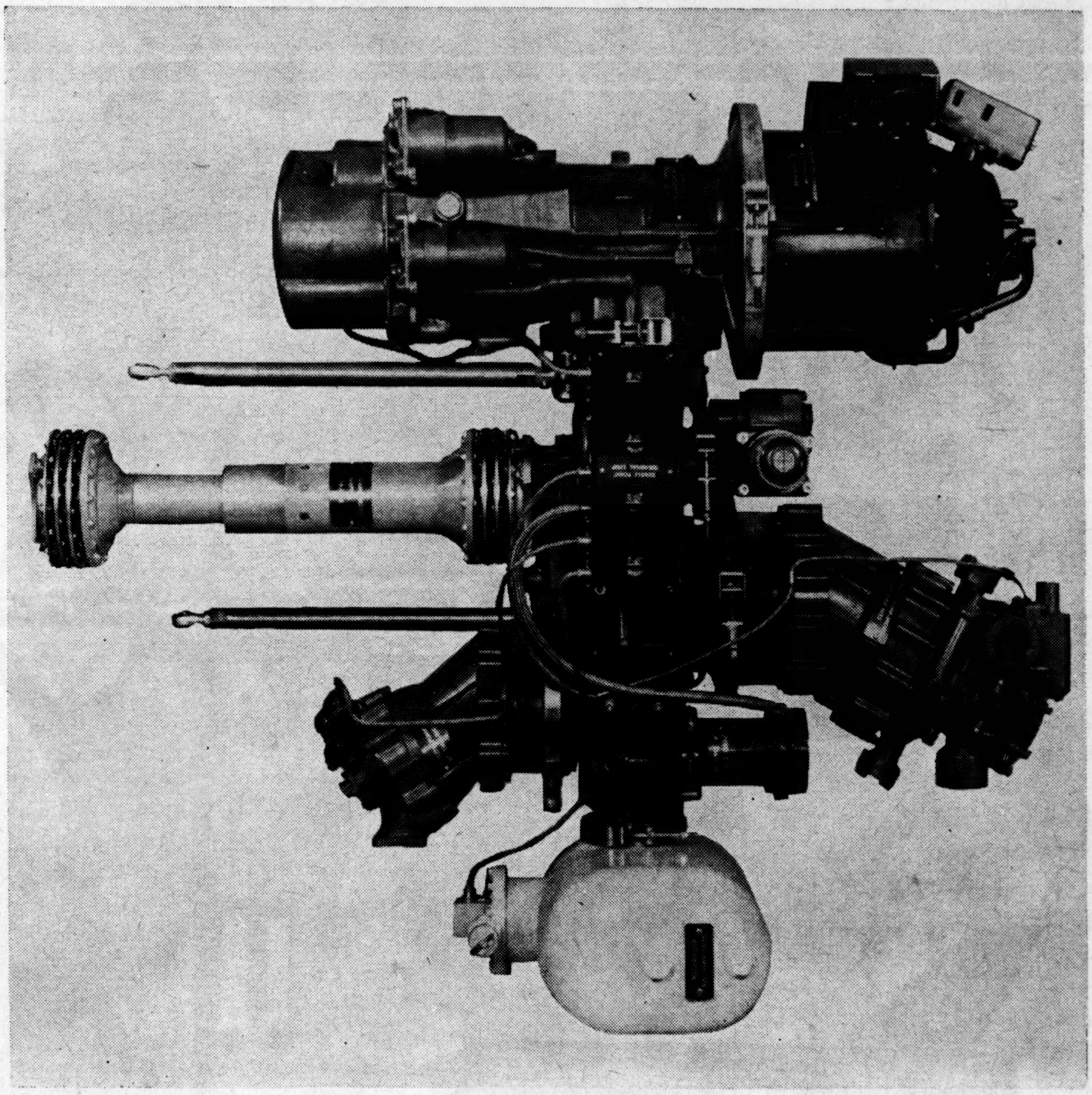
By Barry Tully

Rockford, Ill.—Complete dependence upon secondary power for flight control of the North American B-70 bomber places severe reliability demands on the power generating subsystem, which operates at 500F ambient conditions.

The secondary power generation subsystem, under the management of Sundstrand Aviation, Rockford, Ill., supplies all major power on the B-70 other than propulsion. Primary and utility hydraulic system pressure, a.c. electrical and engine starting power are produced by the secondary power packages. Cartridge start units also are part of the subsystem to provide a secondary engine starting source.

The secondary power generating system consists of six 450-lb. power generation packs located above the engine inlet ducts forward of each General Electric J93-3 turbojet. Driven from the accessory section of the J93, each of these power units provides about 400 hp. to drive the hydraulic pumps and a.c. generators. Primary design considerations were to provide a reliable power package with high power-to-weight ratio capable of operating under 500F ambient temperature conditions.

The four inboard-engine power packs will supply both hydraulic and electrical power on the YB-70 aircraft and the two outboard-engine power packs will supply hydraulic power.



MOCKUP shows configuration of a B-70 secondary power generation package. Mounted flat forward of each J93 turbojet, the units include a constant speed drive/generator combination (top) and primary and utility hydraulic pumps (bottom).

Power Units

The four inboard power generation units are composed of six main components:

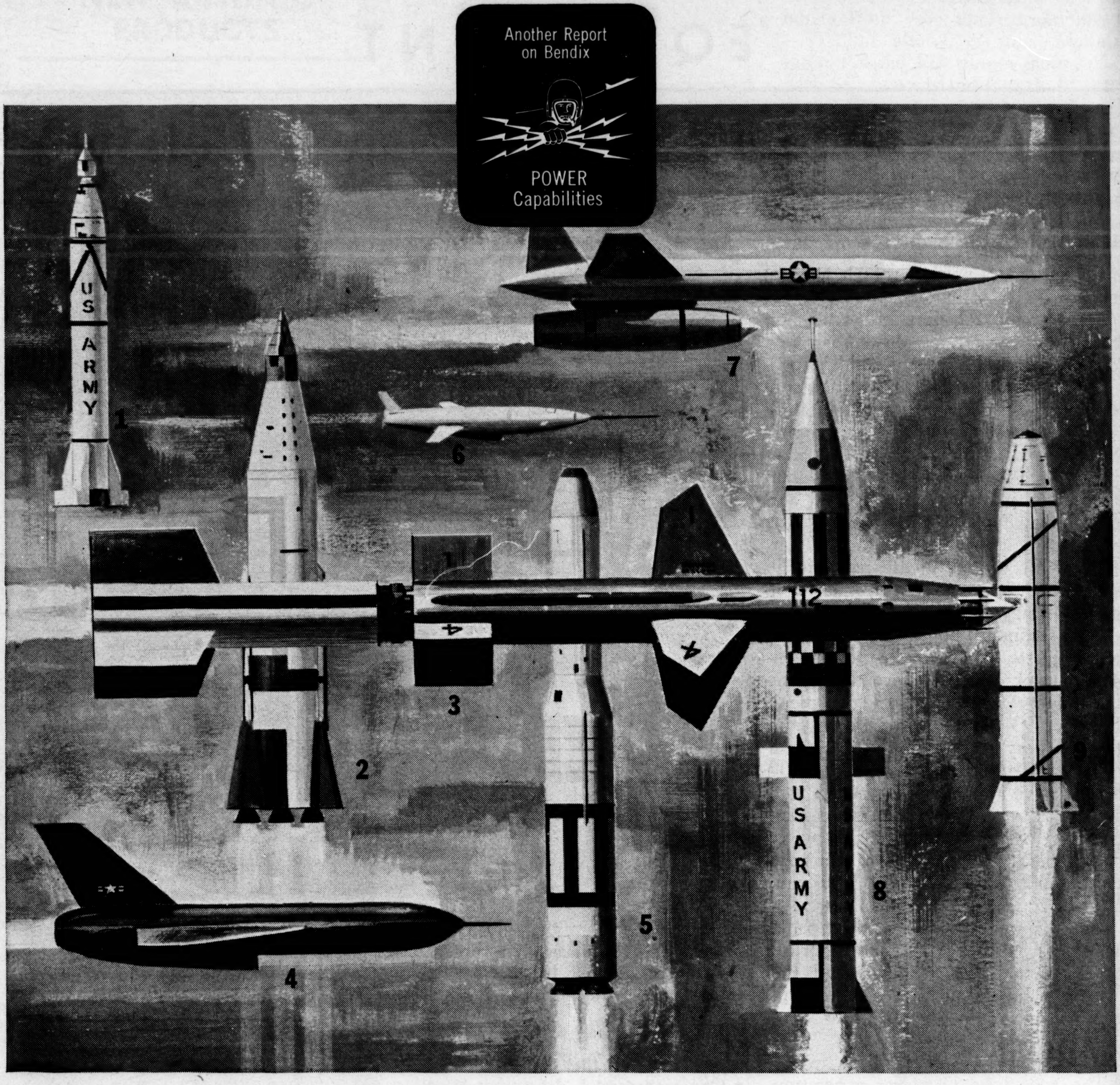
- **Power transmission shaft,** produced by Bendix's Utica, N. Y., Division, transmits torque from the engine accessory pad to the gear box of the power unit.
- **Gear box produced at Sundstrand's** Denver, Colo., facility distributes the power to the various system components.
- **Hydraulic rotary pump** motor, of 5 cu. in. displacement, is used to start the turbojet engines, after which it produces 4,000-psi. primary hydraulic system pressure. External hydraulic power will be used to energize the hydraulic motor.
- **Utility hydraulic system pump,** of 2.5 cu. in. displacement, pressurizes the aircraft utility hydraulic system which handles transient hydraulic loads. Both hydraulic pumps are produced by Vickers, Inc., Detroit, Mich. The Vickers Division of Remington Rand Corp. will produce all the rotating hydraulic components on the aircraft.
- **Constant speed drive,** produced at Sundstrand, Denver, supplies a constant 8,000 rpm. to the electric generator.
- **General Electric** a.c. generator is driven from the constant speed drive to provide high voltage electric power. All four generators will produce 416 v.a.c. power and the current will be decreased where necessary to 208 v. The purpose of the high voltage transmission is to afford weight savings.

The two outboard-engine power units supply primary and utility hydraulic pressure and will be equipped for cartridge engine starting. Thus, the aircraft is equipped with six primary and six utility hydraulic pumps and four a.c. generators. The importance of the flight control system to flight safety demands redundant systems to reduce the possibility of complete system failure. The importance of the hydraulic system is emphasized by the six primary and utility pumping units. This means that if the aircraft lost three engines the pilot could command—at the very worst—50% of his hydraulic power and 25% of his electrical power. It is assumed that by reducing speed and altitude this would be sufficient to effect a safe landing with 50% propulsive power available.

XB-70 Prototype

Canceling of the military subsystems on the single-prototype XB-70 aircraft lessened the electrical power requirements. This permitted redirection of the secondary power generating subsystem to the extent that two constant speed drive generator packages were eliminated. Thus, the XB-70 aircraft has full hydraulic power and one half the electrical capacity of the YB-70 and later model aircraft.

Sundstrand emphasizes that at no time was the development of the secondary power subsystem halted, despite the fluctuating nature of the B-70 project. Reliability and qualification testing of system components, while not dispensed with, suffered a



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There is sound reason why Bendix® inverters and AC and DC generating systems are specified for so many U.S. missiles and satellite boosters. It is because these advanced Bendix electrical power packages combine the advantages of full power supply, complete dependability, light weight small size, and extremely broad versatility.

Bendix electrical power helps put the "Sunday punch" in such missiles as: ① Jupiter, ② Atlas, ③ Talos, ④ Osprey, ⑤ Titan, ⑥ Regulus, ⑦ Hound Dog, ⑧ Pershing, and ⑨ Thor.

In addition to these critical space applications, Bendix electrical power is on the job with Grumman's W-2-F, Chance Vought's F-8-U, Sikorsky's HSS-2, the Douglas A4D, Republic's F-105, and many other aircraft.

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reduction as a result of subsystem redirection.

Engine starting on the XB-70 also was modified in the interests of economy. The original weapon system concept called for simultaneous hydraulic starting of all six powerplants from the alert pod's hydraulic pump. Two propellant cartridge start systems were to be installed in the outboard-engine secondary power packs to free the aircraft from dependence upon the alert pod.

The XB-70 experimental prototype does not have the cartridge start capability, thus it cannot be started without external hydraulic power. This should not hamper development testing with the prototype as it is unlikely to be flown from airstrips lacking servicing equipment. Starter cartridges were put back on the YB-70 program along with most of the military subsystems. This permits YB-70, which is designed to operate from any B-52 runway, to start even without its alert pod or ground support equipment.

Despite the high ambient temperatures associated with Mach 3 flight and their predicted adverse effect on hydraulic fluids and systems, the B-70 relies more on hydraulics than many subsonic aircraft. North American, to improve component reliability and minimize leaks, has designed a system employing large diameter stainless steel tubing which is welded together. Special techniques have been developed to cut and reweld the tubing quickly when necessary.

The 4,000-psi. primary hydraulic system performs the following functions:

- **Flight control surfaces** are fully powered by the primary hydraulic system. This includes the two vertical stabilizer rudders, the elevons which also serve as flaps and the wing tip ventral fold actuation.
- **Fuel boost and transfer** pumps are powered by the primary hydraulic system. Fuel transfer in the B-70 aircraft must be considered as part of the flight control system. To take advantage of compression lift, fuel must be transferred aft with high Mach speed increases to match the center of gravity with the center of lift.
- **Environmental control system's** hydraulic requirements are supplied by the primary system.

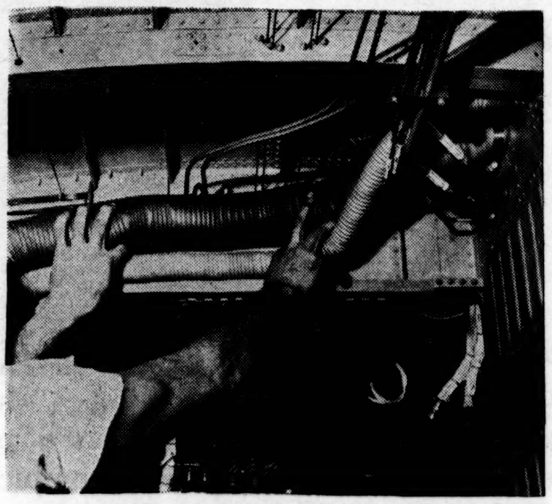
The utility hydraulic system actuates the air induction control system and the canard trim actuation. The air induction system slows inlet air to efficient ingestion speeds without creating excessive drag upon the loss of an engine. This permits the B-70 to complete a mission after loss of an engine with only slight degradation of performance.

The canard control surface, controlled by the utility hydraulic system, provides a vernier control over the nose attitude while transferring fuel when in compression lift flight regimes. Additionally, the canard surface permits pitch control on landing and takeoff when the elevons are operated as flaps.

The electrical system of the B-70 supplies the controls and display equipment and the lighting, flight control and central air data system. The B-70 also will be equipped with electronic offensive and defensive systems. This includes a bomb navigation system with its inertial guidance and star tracking navigation, and programed computer which accepts in-flight inputs to provide a constant "time and distance to go" readout. Search radar and doppler radar also are included in the bomb-nav avionics system.

The defensive avionic system, operated by one crewman, includes both passive and active (jamming) electronic countermeasures equipment. Infrared sensors and countermeasures are at the disposal of the defensive system operator as well as decoys of various types.

The mission and traffic control system developed by Motorola for communication, navigation, identification and landing aids is designated AN/ASQ-43. This system will provide both short-range air traffic control and air-to-air communication and long-range radio equipment. The long-range gear will be used for flight redirection (including positive recall), battle damage assessment and reconnaissance reporting. A recorder will provide a transcript of all radio transmissions as well as flight data. Included in the mission and traffic control system are improved Tacan equipment, ILS system with an absolute altitude indicator for landing approaches, and an IFF system. The bomber also will be equipped with rendezvous beacons to aid flight refueling and an automatic crash locator beacon.



S-61L Ducting

Air conditioning and heating system in the Sikorsky S-61L transport helicopter employs flexible tube ducting to afford weight savings. Tubing, incorporating a nylon helix, saves 10 lb. over metal ducting in the helicopter's air conditioning system. The duct manufacturer is Flexible Tube Corp., Guilford, Conn.

Bomb damage assessment system of the B-70 is part of the defensive subsystem of the aircraft and is under contract to the Eastman Kodak Co. Rochester, N. Y.

The Beech-Aviation-developed alert pod, although not part of the secondary power system, furnishes hydraulic pressure for engine starting. This turbine-powered unit supplies both electrical power and enough hydraulic pressure to start all six engines simultaneously.

This quick start capability, along with the "shirt-sleeve" environmental concept which obviates the need for cumbersome pressure suits, decreases the reaction time in scrambling the B-70. Cartridge starts would not ordinarily be employed, their primary purpose being to provide a self-start capability.

PRODUCTION BRIEFING

Boeing Bomarc site construction program for Canada will be expedited by a new firm, DCF Systems, Inc., a consortium formed of de Havilland of Canada, Canadian Aviation & Electric and Ferranti-Packard. New company, headed by W. H. Jackson of de Havilland, will provide technical support and management for two sites now being built.

Canadair CL-41 primary jet trainer has accumulated 160 hr. of engineering flight test and demonstration time, with only two flight cancellations. One was due to a hydraulic leak and the other to an over-temperature condition on its Pratt & Whitney JT12 turbine, and this was traced to instrumentation, according to Ian McTavish, test pilot.

Aerojet-General's Avionics Division, Azusa, Calif., has received a $12-million contract from Lockheed Missiles and Space Division for fabrication and delivery of an undisclosed number of Midas infrared subsystems. Contract also calls for extensive reliability tests.

Cannon Electric Co., Phoenix, Ariz., has received a contract for an undisclosed amount from the Martin Co. for umbilicals for Titan II.

Ling-Temco Electronics, Inc., received a contract exceeding $100,000 to produce aluminum pods for the Army Sergeant missile ground support equipment generator.

Chance Vought Corp.'s Electronics Division has established four major operating branches—automatic controls, electronic systems, radiation systems and guidance systems.

QUIET PLEASE

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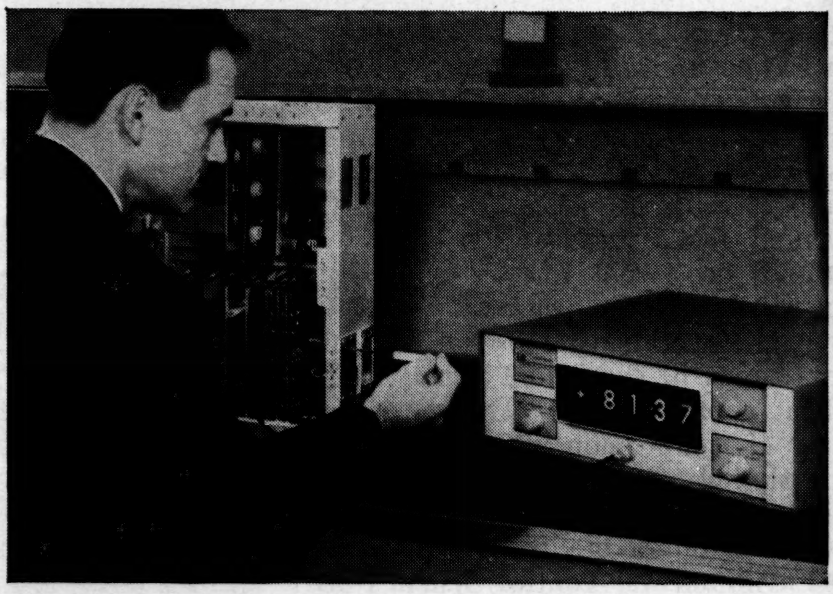

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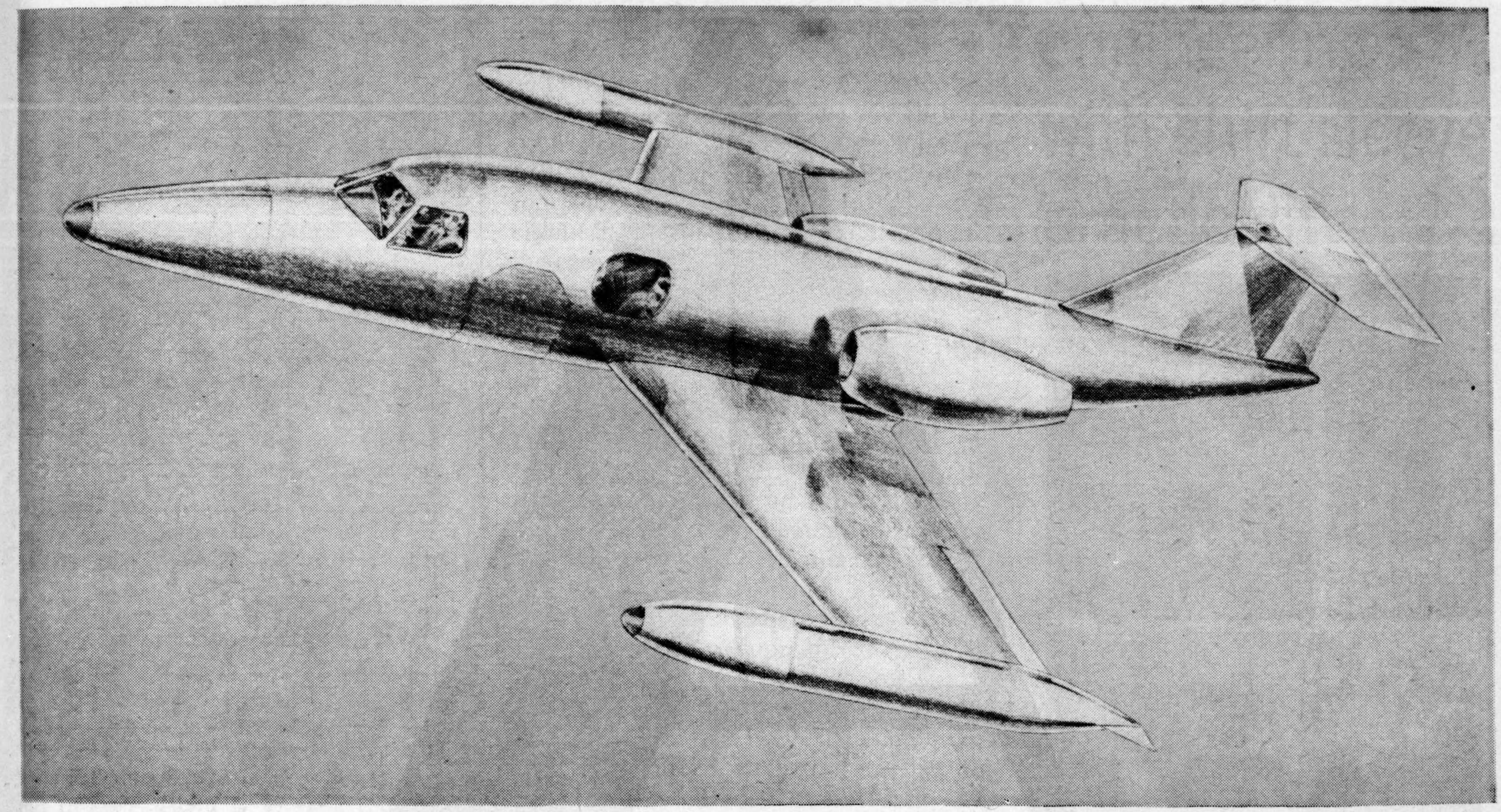

SAAC 23 underwent 23 design changes before the manufacturer, Swiss American Aviation Corp., accepted the final design shown above.

Overseas Firms Plan Executive Transports

By Cecil Brownlow

Geneva—At least three firms on this side of the Atlantic are mapping major invasions of the U. S. business aircraft market by the mid-1960s with relatively low-cost, multi-passenger turbine executive transport designs.

The companies are:

- **Swiss American Aviation Corp.**, a new organization formed by U. S. industrialist William P. Lear, Sr., with a twin-jet eight-passenger executive jet, the SAAC 23 (AW Oct. 3, p. 47), at a stripped-down cost of $250,000 each.
- **Israel Aircraft Industries** of Tel Aviv, with a twin-jet seven-passenger transport designated the B101C, selling for approximately $300,000. Probable powerplant for both the SAAC 23 and the B101C is the General Electric CJ-610-2B (civil J85), a derated version of the standard 2,800-lb.-thrust CJ610 with a thrust rating of about 2,400 lb.
- **Piaggio**, of Genoa, Italy, with a twin-jet executive transport probably designed along the general lines of the company's Gull series and powered by Canadian Pratt & Whitney PT6 turboshaft engines with a normal rating of 400 shp. each. Douglas Aircraft Co. will lend its technical know-how to the project; Piaggio and the Italian government will split development costs on a roughly 50-50 basis.

Final details of the Piaggio design are being closely guarded until negotiations with Douglas and the Italian government have been completed. It is believed, however, that the aircraft will have a gross weight of approximately 12,000 lb. and incorporate the gull wing of its piston-powered predecessors.

A higher-performance straight-wing version incorporating the more-advanced 3,000-lb.-thrust Pratt & Whitney JT12 also is under consideration by Piaggio.

Certification

First flight and Federal Aviation Agency certification of both the SAAC 23 and the B101C are now scheduled for 1962.

Israel Aircraft Industries also hopes to begin initial deliveries in 1962—a schedule that some persons familiar with the project term "overly optimistic"—while Lear is programing his first delivery date for January, 1963.

Both aircraft also follow the same general exterior lines—low wing with the powerplants mounted Caravelle-style on pylons on either side of the rear fuselage section. Gross weight of each aircraft is expected to be in the 12,000-lb. category.

Maximum range for the SAAC 23 is quoted at 2,200 mi.; for the B101C it is 2,000 mi.

Cruising speed for the SAAC 23 at an altitude of about 30,000 ft. is estimated at 525 mph.

Designers of the B101C say their aircraft should cruise at approximately 540 mph. at an altitude of between 30,000 and 35,000 ft.

The major shortcoming of the B101C, when compared with the SAAC 23 specifications, is its projected landing requirement—3,500 ft. of runway as compared with 1,700 ft. for Lear's aircraft—that could sharply cut its market potential in areas where airports available to executive planes cannot accommodate such requirements. Its developers, however, are still modifying the design and hope to trim the landing needs by a substantial margin.

Market Potential

Lear, who believes there may be some 2,000 customers over a 10-year period for the SAAC 23 in the executive, military and airline fields, says that, nevertheless, he can sell a fairly small number of aircraft and still make a profit. Al Schwimmer, managing director of Israel Aircraft, predicts a market for between 200 and 500 aircraft per year, but adds that a profit can be realized, if necessary, at a production rate of three planes per month extending over a number of years.

Seating arrangement in the B101C includes two single seats along either

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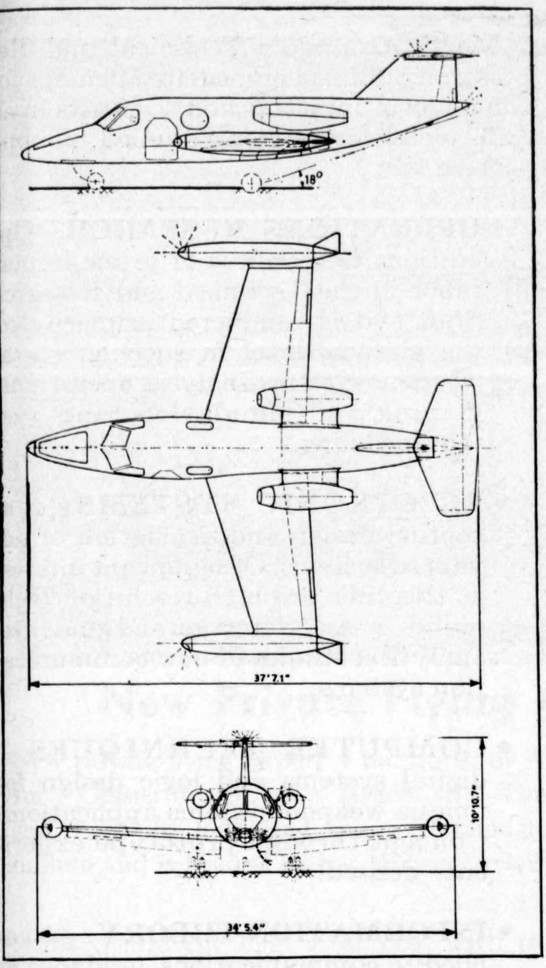
To explore professional opportunities in other Honeywell locations, coast to coast, send your application in confidence to Mr. H. D. Eckstrom, Honeywell, Minneapolis 8, Minnesota.



WINGSPAN of SAAC 23 is 34 ft. 5.4 in. and fuselage length is 37 ft. 7.1 in. Maximum twin-engine speed will be 600 mph.

side of the fuselage plus a back bench seating three. Both the Israeli aircraft and the SAAC 23 include provisions for a pilot and copilot, although Lear says a copilot will not be needed for routine operations. Lear, who believes he has a unique arrangement, is keeping his projected seating configuration quiet for the present.

Wind tunnel testing of the B101C is presently scheduled to begin in France sometime this spring. Flight program for the two prototypes, not including FAA certification tests, calls for approximately 150 hr. over a four- to six-month period.

An earlier design, the B101B, with a gross weight of 9,680 lb. and a projected range of 1,200 mi., was built around the 1,700-lb.-thrust Continental J69 powerplant. A tentative switch has been made to the more powerful CJ-610-2B in order to gain improved performance and extended range. The decision, if it remains intact, will mean an increase in cost to the manufacturer of approximately $56,000 per aircraft since the quoted price for the CJ610-2B is $45,000 per unit as opposed to $17,000 for the J69.

Lear also has considered the J69 and says he has not yet definitely settled on the General Electric powerplant although it "is in the lead at present." He signed a bailment agreement in January for delivery of a CJ610 mockup to the St. Gallen, Switzerland, plant of SAAC's Swiss subsidiary, Swiss American Aviation Development S. A. The parent Swiss American Aviation Corp. is incorporated in Delaware.

Lear reports that the SAAC 23 design went through 23 configurations before it was finally decided upon "with the basic idea always in mind of holding down the cost." A relatively low cost, he believes, is the major key to large sales.

Commenting on cost vis-a-vis sales potential, Lear, board chairman of Lear Inc., says:

"I know that I couldn't go to my corporation and ask for a $900,000 airplane. I couldn't support it."

Component manufacturers who have dealt with Lear on the project have been impressed by his hammering insistence upon maximum reliability at the lowest possible cost and Lear himself says:

"We're solving the problem of the

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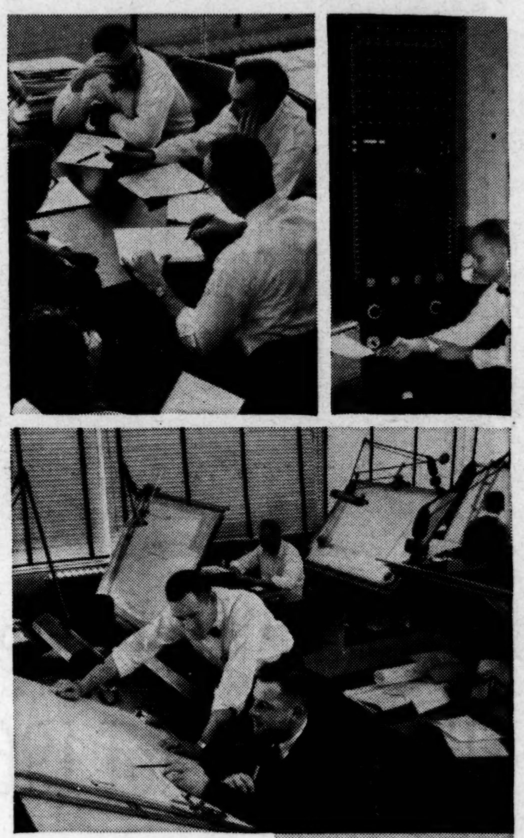
Okanagan Buys Sikorsky S-62 Helicopter

Okanagan Helicopters, Ltd., Vancouver, B. C., has purchased this Sikorsky S-62 for military contract work at Goose Bay, Labrador. Company hopes eventually to start scheduled passenger service between Vancouver and Victoria, B. C. (AW Aug. 17, 1959, p. 123), probably using multi-turbine helicopters, and will use the S-62 for experience.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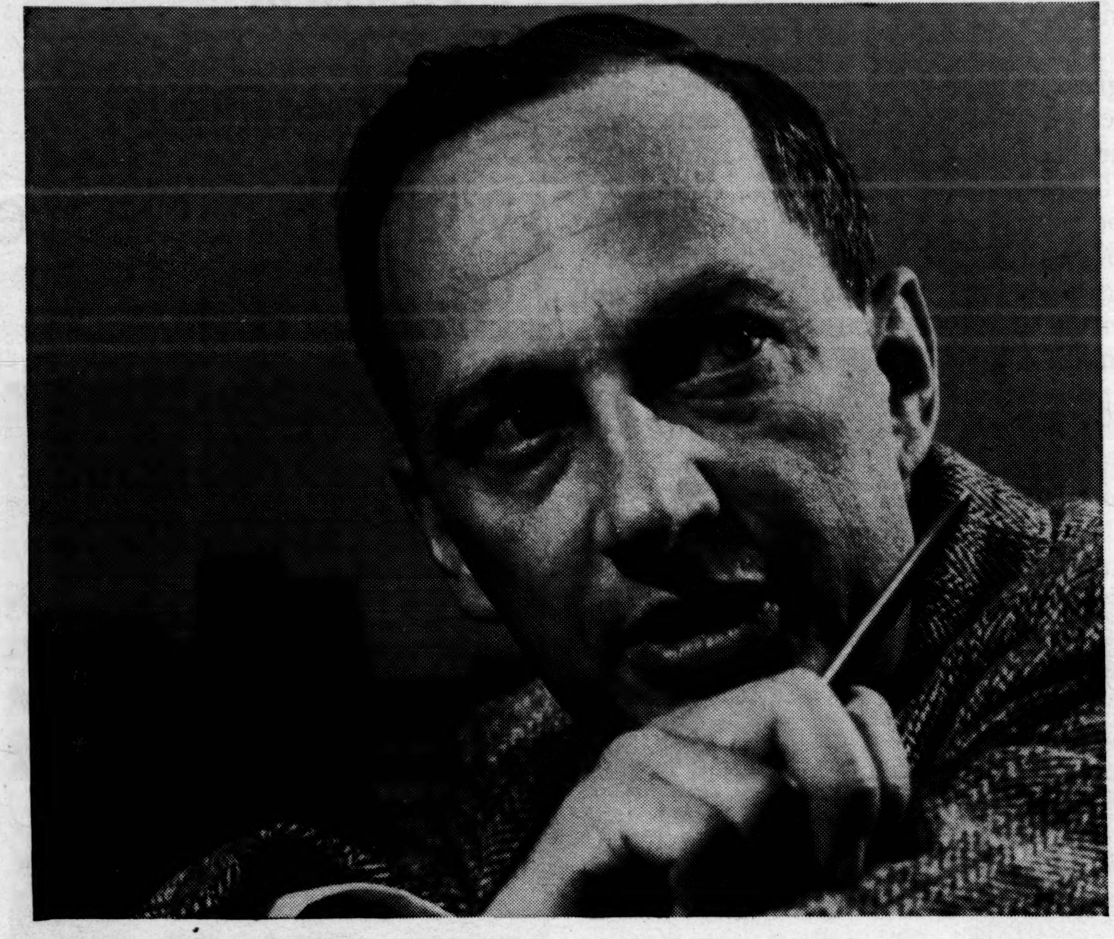


Needed: Engineers to chart the dimensions of 1965 weapons systems

"Too often companies are satisfied with the accomplishments of today and allow schedule pressures to prevent concentration on tomorrow's business.

"This is not true at Martin-Orlando. We have established a group of high level engineers—the Technical and Research Staff—who have the responsibility for creating and developing the skills and systems that will form the basis for Martin's business in the time span 1965-1970.

"Finding the men who can staff the 23 technologies necessary is not an easy task. It calls for engineers who are interested in technical rather than administrative accomplishment. It calls for engineers who have the clarity of concept to discard convention. It calls for engineers unhampered by 'tunnel vision'—who can translate the tactical requirements of the future into engineering reality. It calls for engineers who can do the jobs and meet the qualifications shown on the right.

"Martin-Orlando—prime contractor for Pershing, Bullpup, GAM-83, Lacrosse, Missile Master and BIRDiE—is working on the threshold of the future. If you feel you would like to join us, are qualified, and would enjoy living in Florida, we would very much like to hear from you."

James G. Houser

Director, Technical and Research Staff

Martin-Orlando's Technical and Research Staff has immediate openings for high level engineers and scientists in all 23 technologies being studied. Among these are:

- **OPERATIONS RESEARCH**—Operations Research is of prime importance in the Technical and Research Staff and is conducted primarily on the systems level in such efforts as weapons systems analysis, operational gaming and simulation, and system modeling.
- **ELECTRONIC SYSTEMS**—conceptual design and evaluation of advanced systems. Of significant interest at this time are high resolution techniques, missile detection and guidance, analytical studies of new communication systems.
- **COMPUTER TECHNIQUES**—digital systems and logic design for unique weapon systems applications. Concept through prototype experience desired.
- **INFORMATION THEORY**—as applied to communications, guidance or radar systems with emphasis on information theory, information processing, statistical theory of communications, decision theory, optimum coding and detection.
- **INERTIAL GUIDANCE**—conceptual and analytical investigation of advanced inertial guidance systems. Experience should be in modern weapons systems with emphasis on systems analysis for employment of inertial guidance techniques, and/or conception and design of all or major portions of inertial guidance components.
- **GROUND SUPPORT EQUIPMENT CONCEPT AND DEVELOPMENT**—emphasis on mobile missile systems analysis. Backgrounds in missile and equipment handling, servicing equipment development, transport and transport vehicle evaluation, soil mechanics, hard based installations, and power generation systems are applicable. Experience with military logistics and tactical military operations highly desirable.

Other technologies in which immediate openings exist include: Electronic Packaging, Environments Prediction, Structures (Conceptual Analysis and Design), Human Factors, Missile Propulsion.

If you are interested in and qualify for senior level work with this highly select staff, please contact C. H. Lang, Employment Manager, The Martin Company, Orlando 26, Florida.

WORK IN THE CLIMATE OF ACHIEVEMENT

MARTIN
ORLANDO

New Private Flying Airport at Albuquerque

New private flying airport 4 mi. north of Albuquerque, N. M., has been built by Aviation, Inc., Cessna dealer, on a 10-acre site. Coronado Airport has two lighted runways—3,300 and 3,500 ft. long—and can accommodate up to 200 airplanes. Facility cost about $1 million and is headed by Joe Wilson, Aviation, Inc., president.

chicken and the egg. Low cost with no sacrifice in reliability."

In some instances, he adds, "we've managed to reduce cost by 50% over the quoted price because we kept saying that they [the manufacturers] must meet our figures."

As a further means of cost cutting, Lear plans to subcontract the airframe components to several European manufacturers and ship the aircraft to the U.S. as a bare hull without engines, instrumentation or interior finishings. Such a plan not only reduces shipping and customs costs that would be incurred by sending engines and components from the U. S. for installation in the airframe and then shipping the completed aircraft back to the U. S., but also eliminates what Lear terms the "multiple profits" thesis adopted by some manufacturers. He says:

"Some people want to hog all the profits they can on equipment. Then the distributor gets his profits on the same items. We're eliminating this idea. If we didn't, the basic cost would be a minimum of $400,000.

"This way, we will sell the airframe to the distributor, and we're through there. He will be the only person to make a profit on the engines and equipment."

Lear also hopes to subcontract for manufacture of some SAAC 23 components in Japan and recently visited Mitsubishi's aviation division to discuss details, including the possibility of building a SAAC 23 prototype in Japan.

With a basic cost of $250,000 including engines, Lear estimates that, after instrumentation and interior finishings, a customer can "get by for as low as $325,000 in total cost if he doesn't go hog wild."

The demonstrator aircraft planned by Lear will have approximately $75,000 in equipment aboard. "If the customer wants something different, he will have to pay substantially more for it," Lear said.

The plane, according to Lear, was designed from the ground up as a commercial executive jet transport and, "as a pilot and navigator, I know the requirements here and how simple these aspects have to be" for such an aircraft. He envisions an even larger market, however, among the military services of a number of nations and believes airlines will want it as a high-priority freight carrier—"for instance, when they have a Boeing 707 sitting on the ground for want of a part."

Lear already has discussed the aircraft with U. S. Army officials as a potential liaison plane and says it also could serve a dual purpose with the installation of two bays carrying a total of 96 2¼-in. rockets.

All 96, Lear says, could be fired from the aircraft within 10 sec.

Tire loading for the aircraft is approximately the same as that for a fully-loaded jeep, a point that should permit it to operate from unprepared sod fields.

Wingtip Tanks

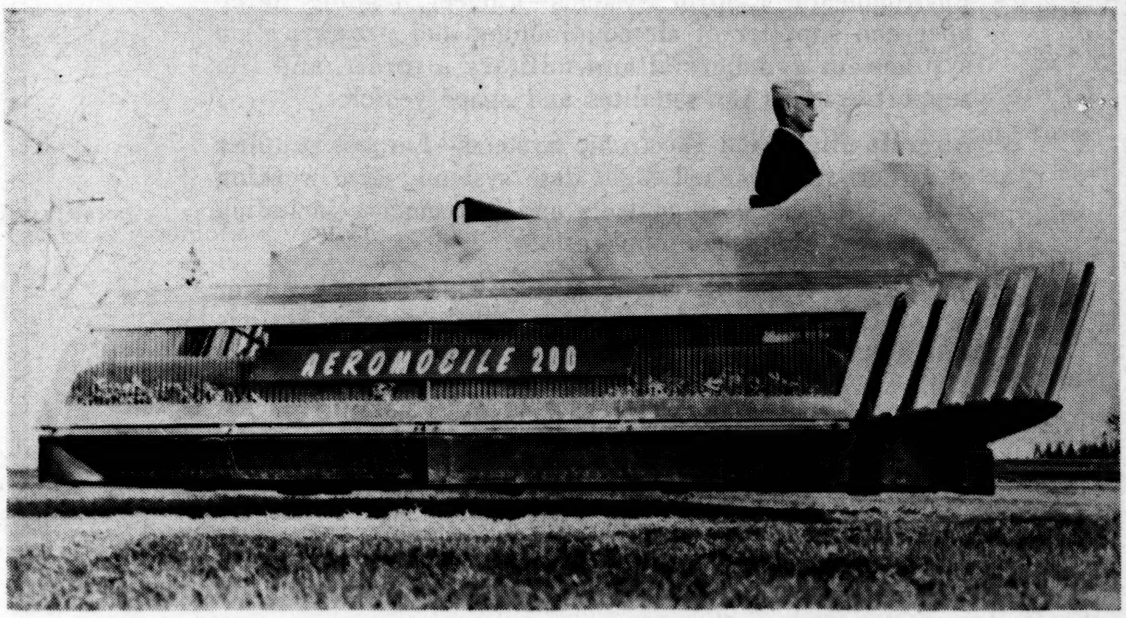
As the design has evolved, two permanently-installed wingtip tanks carrying 170 U. S. gal. each have been added in order to gain the 2,000-mi.-plus range.

The aircraft, according to Lear, can reach its optimum performance level of 30,000 ft. "in less than 10 min." and can climb at a rate of 2,000 fpm. on one engine until it reaches the single-engine ceiling of 20,200 ft. Maximum single-engine speed at this altitude would be 405 mph. Single-engine range, Lears adds, would be 90% of normal range.

Maximum twin-engine speed would be approximately 600 mph.

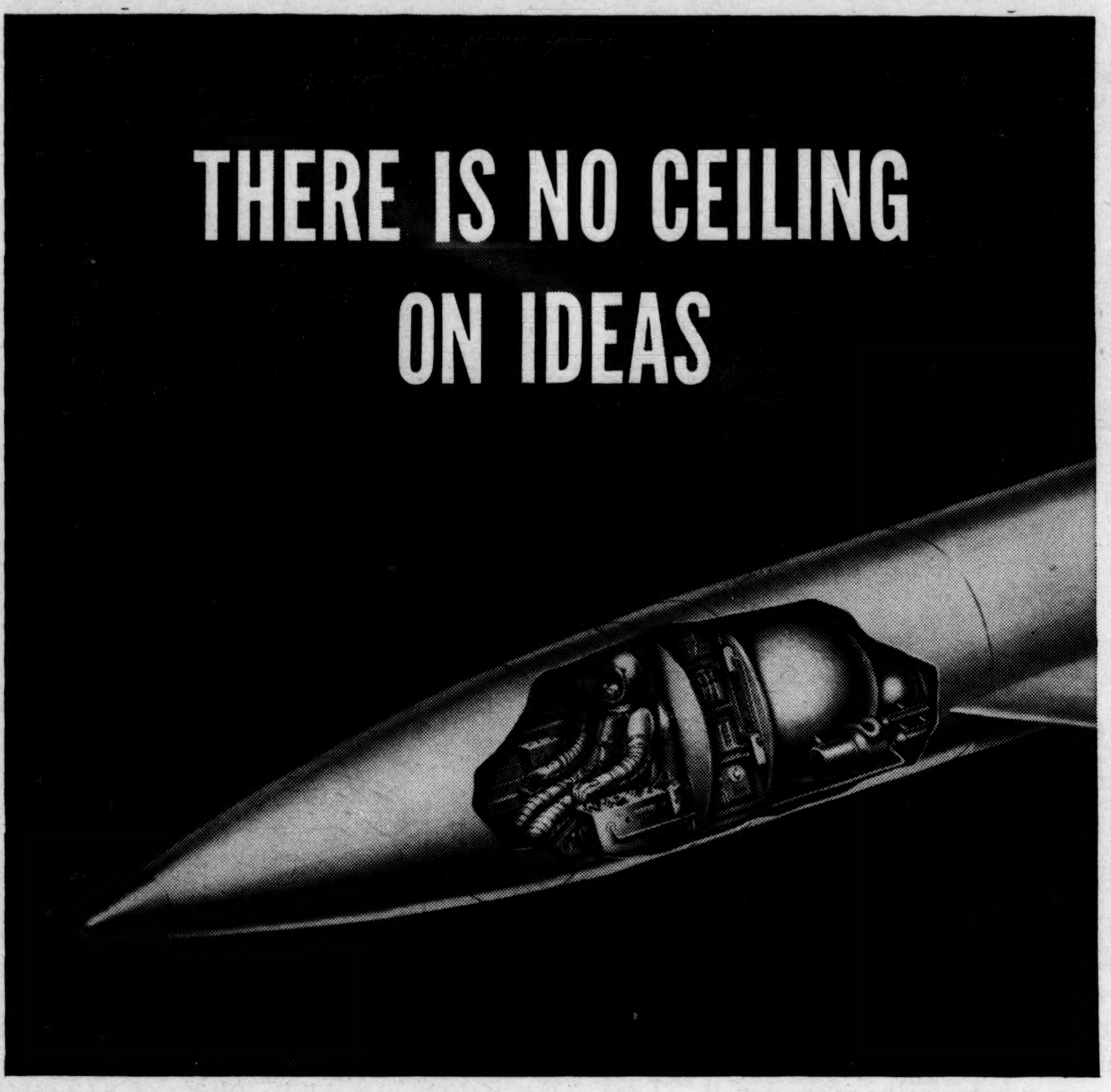
Plans include a completely pressurized cabin, a heated birdproof windshield and an independent auxiliary electrical system for emergencies.

Wingspan is 34 ft. 5.4 in. and fuselage length is 37 ft. 7.1 in. Lear says the fuel consumption rate will allow over 3 mpg. of kerosene or jet fuel.



Bertelsen Aeromobile Displayed

Four-passenger Aeromobile 200 ground effect vehicle is being built for U. S. Department of Commerce's Office of International Trade Fairs for showing overseas, according to builder William R. Bertelsen, Neponset, Ill. (AW Sept. 7, 1959, p. 111). First showing will be at U. S. International Trade Fair in Tokyo next April. Of aluminum and Fiberglas construction, the Aeromobile is powered by a 200-hp. aircraft engine and is said to attain a maximum altitude of 12 in. at 2,400 lb. gross weight and have a maximum continuous forward speed of 60 mph. Dimensions include: length, 16 ft.; width, 8 ft.; height, 5.5 ft. The machine also is to be shown at fairs in Italy in July and at Zagreb, Yugoslavia.



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- **Gas Turbine Engines—World's largest producer of small gas turbine engines, with more than 9000 delivered in the 30–850 hp class. Studies include industrial and nuclear applications.**

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Send resume to: *Mr. T. E. Watson*

THE GARRETT CORPORATION
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Los Angeles 45, California • Phoenix, Arizona

WHO'S WHERE

(Continued from page 23)

Changes

W. L. Duval, assistant chief engineer for missiles and space field operations, Douglas Aircraft Company, Inc., Santa Monica, Calif., and **B. E. Stitt**, assistant chief project engineer-Nike systems. **G. F. Hanson** succeeds Mr. Stitt as field station manager, Cape Canaveral, Fla.

Daniel B. Campbell, manager-field services, Military Products Division, General Dynamics/Electronics, Rochester, N. Y., a division of General Dynamics Corp.

Herbert J. Cabral, deputy manager-Polaris missile launching and handling project, Westinghouse Electric Corp.'s Sunnyvale (Calif.) Division. **James H. Davis** succeeds Mr. Cabral as supervisor of installation and test-Polaris project.

T. H. Abrahams, chief engineer, Instrument Division, Hoffman Electronics Corp., Los Angeles, Calif.

John C. Forrest, director, and **Dr. Frank N. Gillette**, associate director, Engineering Division, GPL Division, General Precision, Inc., Pleasantville, N. Y. Also: **Louis L. Pourciau**, head of the Industrial Products Department, Engineering Division.

Andrew C. Bayle, staff engineer, Technical Operations, The MITRE Corp., Bedford, Mass.

William C. Cleveland, Jr., assistant manager, Radar and Telemetry, Electronics Operations, Aeronutronic Division of Ford Motor Co., Newport Beach, Calif.

Richard Blythe, project manager, and **David Wilson**, chief design engineer, for cryogenics, Hydro-Aire Co., Burbank, Calif.

James F. Healey, general manager, Minneapolis-Honeywell's Aeronautical Division, St. Petersburg, Fla.

Vernon R. Goldberg, chief mechanical engineer, Applied Microwave Electronics, Inc., Baltimore, Md., and **M. S. Butz**, field sales manager.

Jack T. Wills, director of corporate special projects, Aerojet-General Corp.'s Washington, D. C. staff.

Jay G. McKie, manager-marketing techniques, Central Staff Marketing, Texas Instruments, Inc., Dallas, Tex.

Ryndal L. Wetherington, senior staff member, Research Management Corp., Washington, D. C.

Edward J. Singer, head of the newly established Ground Support and Systems Engineering Division, Tenney Engineering, Inc., Union, N. J. Also: **Ralph A. Sansone**, development engineer; **Hyman Rosen**, chief electronic engineer; **Anthony F. Posella**, systems engineer.

Kenneth M. Gentry, associate director-research and development, Undersea Warfare and Electronic Countermeasures, Motorola Military Electronics Div., Chicago.

Edward G. Schwarm, general manager, Training Division, Burtek, Inc., Tulsa, Okla.

Braniff International Airways Maintenance Division has appointed the following managers: **R. E. Sawyer**-engineering; **B. A. Minter**-aircraft maintenance; **Frank Achilles**-production services; **G. D. Smith**-Minneapolis (Minn.) maintenance base.

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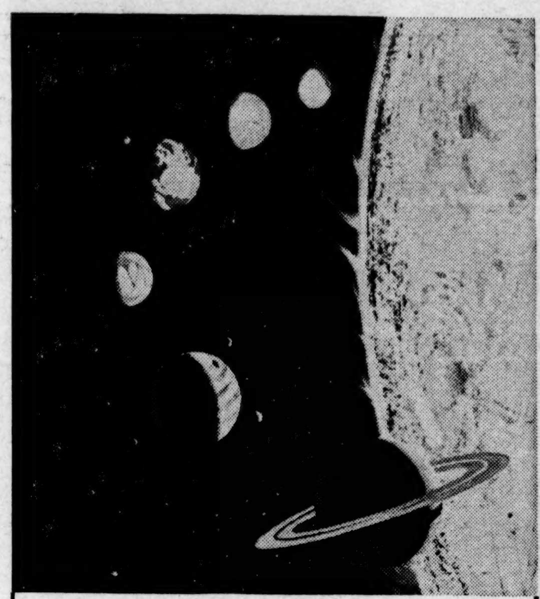

HEAT TRANSFER SPECIALISTS

NAA's Space and Information Systems Division is rapidly extending its capabilities into all phases of research in the nation's developing space program. We have several key positions open in the Structures Technology Group of the Division for engineers with from four to six years industrial experience in heat transfer or thermo dynamics, with background in areas of external heat transfer, radiation studies and structural heating. Will perform applied studies in the area of heat transfer to hypervelocity re-entry vehicles. Develop sets of equations for the prediction of temperatures of and heating rates to various portions of re-entry vehicles for specified trajectories. Apply the developed equations for solution in digital computer programs. If you possess the background and have an intense interest in space vehicles, address a letter or resume to us for more information.

A. W. Cunningham, Manager
Employment Services
12214 Lakewood Blvd.
Downey, California

SPACE AND INFORMATION SYSTEMS DIVISION
North American Aviation

LETTERS

Astronauts Comment

Re: Your editorial, Aviation Week, February 27, 1961. The recognition expressed regarding Project Mercury as a technical scientific program rather than as a circus was most heartening to us. A very fine comment in the midst of hazy reporting elsewhere. Your wishes for success are also appreciated. Let us hope it indeed helps us prove one of the advantages of the democratic system of which we are so proud.

Astronauts Glenn, Grissom, Shepard
Space Task Group
Langley Field, Va.

JATO Power

I note with considerable interest the suggestion of Mr. C. L. Marshall (AW Jan. 30, p. 124) that civilian and military aircraft be equipped with emergency JATO power to be used in case of engine failure at a critical time such as immediately after takeoff or for a "go-around" in the case of an aborted landing. Since this seems such a relatively simple and inexpensive solution to a long existent problem in the aviation field, it is my fear that authoritative people in the industry may not pause long enough to consider the merits of this suggestion. Accordingly, I wish to express "me, too" along with Mr. Marshall.

During my association with the aviation industry I have known of at least two cases in which an extra 100 ft. of altitude would have prevented a tragedy. Also, who can predict what effect a few thousand pounds of "instant thrust" might have had in avoiding some of the midair collisions which have happened recently?

Pete Hieber
Mosher Engineering
Pasadena, Calif.

Armament Threat

Your editorial entitled "The Parthian Shots" (AW Jan. 23, p. 21) is a weak rebuttal to President Eisenhower's warning to the nation of the potential threat of the armaments industry to the future of our nation. Remember that the armaments industry depends upon the government for its livelihood and remuneration; therefore, if it can exercise certain controls over the government it could control its livelihood and economic enrichment.

In the past 10 years I have seen companies start and rapidly grow whose sole business deals with military goods; indeed our military needs have nurtured the worthy incentive for profit. It must be kept in mind, however, that industry furnishes military goods and services primarily for profit and not for the security and well-being of our nation; the latter responsibility belongs to the government. President Eisenhower was entirely correct in telling the nation of the potential threat to our liberty owing to the growing pressures on our government by the vast armament industry.

N. J. Guarino
AF Cambridge Research Laboratories

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Airline Safety Fee

Airline disasters are bound to continue and increase unless drastic steps are taken to make the airways control systems capable of handling modern air traffic problems. I am sure that Aviation Week does not believe that the present control systems are adequate for the type of airline traffic encountered today, let alone being equal to the much more difficult traffic safety and control situation developing as airlines and routes expand with more and faster aircraft.

Unfortunately, few are willing to recognize or face up to the expenditures required to research, develop and design the complex computers, communications and electronic systems required to monitor and control this high-speed dense traffic. We even reluctantly spend the large sums required for comparable electronic developments required by major weapon systems. The pathetic budgets of federal agencies responsible for air traffic safety and control do not even show token recognition of the seriousness of the situation. I question that Congress will finance the costs because it would require large tax expenditures taken from others for application to the benefit of a single industry, namely, air travel. Nor are the airlines spending adequate money on the avionics developments required for jet age safety. Yet there is, in my opinion, a way in which the hundreds of millions, so obviously required now for research and development of air safety systems, can be raised without noticeable hardships on any. The cost should be borne by he who benefits: *make the air traveler pay for his safety*. This is only just and can be done painlessly and effectively.

I suggest that each airline collect a certain percentage of the ticket price for use in an air safety research and development fund. Suppose there are a hundred million tickets sold each year by the commercial airlines of the United States. Imagine that each airline ticket purchaser pay a nominal but suitable surcharge of 1 or 2% on his ticket for such a fund. (Perhaps the airlines might balk at this because they understandably may not like connotations that reflect on safety. Users of the airlines would, I am sure, find it more palatable to pay a surcharge for air safety progress than the surcharge for a jet seat.) The automatic collection of such a fund by the airlines would mean that hundreds of millions of dollars could be made available for the research and development essential toward obtaining air traffic control systems equal to handling today's and tomorrow's traffic problems, and other safety measures crying for attention and money.

I do not think that any passenger would object to such nominal assessments if he knew that all of it were to be used for his safety. Such a fund should be completely earmarked and used for its one purpose: air safety research and development. A nonprofit public "Authority" could be set up with directors selected from airlines, the government, and other associated activities. This "Authority" would use the funds to finance carefully selected areas of research and development in air safety. The actual work would be done under competitive contract from the "Authority" to both profit and nonprofit research establishments. The "Authority" would study the needs, specify the requirements, assess the proposals, ensure development, scope and compatibility, and manage the fund. Both industry and the passenger would benefit. Industry to date has not properly devoted its technical strength to this field, despite the tremendous technical challenge, because it has recognized that neither the federal aviation agencies nor the airlines were prepared to spend the large sums required for significant development work. Painless pennies collected from the travelers can and should supply the funds required.

I do most seriously suggest that an "Air Safety Research and Development Authority," funded by a fitting surcharge on each airline ticket sold, be established immediately so that funds required for the development of equipments and systems capable of handling jet age air traffic can become available to attract and finance the technical efforts so sorely needed.

Russell I. Mason, Technical Director
Anti-Submarine Warfare Laboratory
U. S. Naval Air Development Center
Johnsville, Pa.

'Dollar Vote'

Congratulations to Aviation Week and to reader Donald Williams (AW Feb. 6, p. 126) for the outcry against creeping communism.

One important point to be added is the fact that our nation's growth, its greatnes and its true progress depend upon the tegrity of the dollar-vote. The dollar-v in turn, depends for its meaningfulness up the full cost of each good or commodity being borne by the users of that commodity. This is the unique essence of the free enterprise system that works toward maximum efficiency of production and distribution.

For this reason, the full cost of installation, operation, and maintenance of airports and related facilities should be borne by aviation patrons—as users of these facilities and not as citizen-taxpayers.

The rationalizers and apologizers who argue against self-supporting aviation, or against self-supporting anything else, should be reminded that they are arguing against the very foundation of American economics and, knowingly or otherwise, they are supporting communism.

Alvin L. Spivak
Glendale, Ohio